A STUDY OF A MATHEMATICS PROFESSIONAL LEARNING COMMUNITY AND COACHING PROGRAM

by

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ABSTRACT

Elementary school students who receive free or reduced meal prices underperform compared to their more affluent peers on standardized mathematics assessments. Although policies and legislation like the No Child Left Behind Act of 2001 was to close the achievement gap between disadvantaged students and their peers by the 2013-2014 school year, these gaps persist. This mixed methods study was conducted to explore two second grade teachers' experience in participating in an online professional learning community and a one-on-one coaching program. The Measuring Content Knowledge for Teaching Mathematics Instrument, Teacher Efficacy Scale, Math Teaching Efficacy Beliefs Instrument, observational protocol, exit ticket survey, focus group transcripts, field notes on adherence and participant responsiveness were used to understand the teachers' pedagogical content knowledge and sense of self-efficacy in teaching mathematics. Although major differences were not found from the quantitative pretest to the posttest, qualitative data suggests participation in a professional learning community and coaching program supports teachers' pedagogical content knowledge and sense of self-efficacy.

Primary Reader and Dissertation Advisor: Camille Bryant

EXECUTIVE SUMMARY

Elementary school students who receive free or reduced meal prices underperform on mathematics standardized assessments when compared to their more affluent peers. After reviewing the literature related to the mathematics achievement gap between students who receive free or reduced meal prices and their more privileged peers, contributing factors include societal beliefs about low-income students (Croizet & Claire, 1998; Croizet & Dutrévis, 2004; Spencer & Castano, 2007); policies and legislation (NCLB Act, 2001); relationships between home, school and students (Coleman et al., 1966); and factors related to teachers such as parental level of schooling and beliefs about education (Klebanov, Brooks-Gunn, & Dunkan, 1994; Houston & Xu, 2016; Smith, Brooks-Gunn, & Klebanov, 1997), homelessness and school mobility (Fantuzzo, LeBoeuf, Chen, Chin-Chih, Rouse, Culhane, 2012; Hanushek, Kane, & Rivkin, 2004; Reynolds, Chen, & Herbers, 2009), absenteeism (Balfanz & Byrnes, 2018; Chen & Stevenson, 1995; Gottfried, 2014), teachers attrition (Borman & Kimball, 2005; DeAnglis & Presley, 2011; Hochbein & Carpenter, 2017; Jacob, Vidyarthi, & Carroll, 2012), teacher self-efficacy (Althauser, 2015; Bandura, 1977, Gibson & Dembo, 1984; Tschannen-Moran & Hoy, 2001), and mathematics self-efficacy (Nurlu, 2015; Wilhelm & Berebitsky, 2019; Vinson, 2001). This dissertation study focuses on the teacher factors that are within the researcher's sphere of influence, teachers' pedagogical content knowledge (Ball et al., 2005; Shulman, 1987) and self-efficacy (Bandura, 1977; Bandura, 1997; Gibson & Dembo, 1984; Goddard & Goddard, 2001; Muijs & Reynolds, 2002; Tschannen-Moran & Hoy, 2001), which can influence students' mathematics achievement.

A needs assessment was conducted to examine the factors contributing to the mathematics achievement gap between students who receive free and reduced meal prices compared to their more affluent peers. The participating classroom teachers' perceptions of their pedagogical content knowledge for teaching mathematics and teacher efficacy, as measured by the instruments, Measuring Content Knowledge for Teaching Mathematics (Hill, Schilling, & Ball, 2004) and the Teacher Efficacy Scale (Gibson & Dembo, 1984), in conjunction with the data collected from the classroom observations, revealed varying ability levels in pedagogical content knowledge and self-efficacy. When these measures were coupled with students' standardized achievement, the findings showed that a teacher's low pedagogical content knowledge and self-efficacy could have a negative influence their students' achievement on standardized mathematics assessments (Ball & Bass, 2000).

Based on these findings, a literature review was conducted to seek out possible interventions that addressed teachers' pedagogical content knowledge and self-efficacy. The literature revealed mathematics professional learning communities and coaching cycles can positively influence teachers' pedagogical content knowledge and self-efficacy (Bruce & Ross, 2008; Gee & Whaley, 2016). Furthermore, research reveals participation in professional learning communities (Gee & Whaley, 2016) and coaching (Campbell & Malkus, 2011; Biancarosa & Bryk, 2011; Powell & Diamond, 2011) are effective in increasing students' achievement in mathematics.

A mixed methods evaluation was conducted to explore two second grade teachers' experience in participating in an online professional learning community and a one-on-one

coaching program as well as outcomes related to changes in their pedagogical content knowledge for teaching mathematics, self-efficacy, and math teaching efficacy. The Measuring Content Knowledge for Teaching Mathematics instrument, Teacher Efficacy Scale, Math Teaching Efficacy Beliefs Instrument, observational protocol, exit ticket survey, focus group transcripts, field notes on adherence and participant responsiveness were used to understand the teachers' pedagogical content knowledge and sense of self-efficacy in teaching mathematics. Although there were only slight increases from the participants' pretest to the posttest scores on the Measuring Content Knowledge for Teaching Mathematics instrument, the Teacher Efficacy Scale, and the Math Teaching Efficacy Beliefs Instrument, qualitative data suggests participation in a professional learning community and coaching program supports teachers' pedagogical content knowledge and sense of self-efficacy.

DEDICATION

This dissertation is dedicated to my family:

To my father, Ronnie Ferrer, who shows me the power of hard work and perseverance,

To my mother, Sandra Ferrer, who stresses the importance of education and provides endless encouragement,

To my grandmother, Estelle Evans, who offers wisdom and strength to guide me through this journey,

To my uncle, David Evans, who is a role model for following your heart and your ambitions,

To my siblings, Rachel Johnston and Ronnie Ferrer, for being my first and favorite students,

To my children, Russell Brittian, Raegan Barnes, and Kailani Barnes, who have made sacrifices for me to accomplish my dream and inspire me to become the best version of myself,

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Finally, I want to express my deepest appreciation for our family dog, Fletcher, who spent countless hours by my side every step of the way. This dissertation is dedicated in his memory.

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CHAPTER 1

Literature Synthesis of Factors Related to the Achievement of Lower-Income Students

Academic achievement is influenced by a student's socioeconomic status (Goudeau, Autin, & Croizet, 2017). Before students enter school, an achievement gap between socioeconomic statuses exist and increases as students progress through school, most prominently in mathematics (Galindo & Sonnenschein, 2015; Jordan & Levine, 2009). In a discussion of the historical educational trends in the United States, specifically the Early Childhood Longitudinal Study, Snyder, Brey, and Dillow (2019) found the average mathematics scores were higher for first-time kindergartners from families with a higher socioeconomic status than for those from a lower socioeconomic status. Additionally, mathematics scores were higher for fifth graders from a higher socioeconomic status than for those from lower socioeconomic status (Snyder, Brey & Dillow, 2019). Von Stumm and Plomin (2015) found that even two-year-old children from the highest and lowest socioeconomic status were, on average, separated by six intelligence quotient (IQ) points. By the time a student turned 16 years old, the IQ gap had almost tripled. Von Stumm and Plomin (2015) concluded that a child's socioeconomic status has a deep and everlasting influence on their cognitive development (Deary, Strand, Smith, & Fernandes, 2007; Frey & Detterman, 2004).

The high school dropout rate is higher for students with a low socioeconomic status compared to their more privileged peers (Cui, McFarland, Stark, National Center for Education Statistics, & American Institutes for Research, 2016). The high school dropout rate is determined by "the percentage of 16- to 24-year old students who are not enrolled in school and have not earned a high school diploma or General Equivalency Diploma" (GED; Freeman &

Simonsen, 2015, pg. 206). According the National Center for Education Statistics (2016), the dropout rate for students from a higher socioeconomic status in 2013 was three percent, while the rates for students from a middle- and lower- socioeconomic status were 4.9% and 7.2%, respectively.

The wide variation in high school dropout rates between socioeconomic statuses is a serious concern for educators, policymakers, and the general public (Rumberger, 2011). The economic and social consequences increases for those who do not complete high school, as the needs for a more highly educated workforce has increased (Rumberger, 2011; Swanson & Editorial Projects in Education, 2009). For example, young adults who drop out of high school are more likely to be unemployed and receive welfare benefits (Rumberger, 2011; Swanson & Editorial Projects in Education, 2009). Further, highly educated children generally have higher incomes as adults than their less-educated peers, illustrating that education level is a predictor of adult income (Bloome, Dyer, & Zhou, 2018).

In addition to the drop-out rate, the implications of the mathematics achievement gap on students from high and middle or lower economic statuses has implications on Scholastic Aptitude Test (SAT) scores (Wright, Horn, & Sanders, 1997), college outcomes (U.S. Department of Education, 1997), and the opportunity to successfully major in a science, technology, engineering, and mathematics (STEM) field (Crisp, Nora, & Taggart, 2009; Niu, 2017; Seymour & Hewitt, 1997). Research studies on teacher credentials published since the release of the Coleman Report (Coleman, Campbell, Hobson, McPartland, Mood, Weinfeld, et al., 1966) have focused on the connection between teacher characteristics and student mathematic achievement (Fetler, 1999; Rowan, Correnti, & Miller, 2002; Wright et al.,1997). Using students' SAT scores, Wright and colleagues (1997) found a positive relationship between teacher knowledge and mathematics achievement of their students. Furthermore, teacher experience has been correlated with achievement gains in both high school mathematics (Fetler, 1999) and elementary mathematics (Rowan et al., 2002). However, students from a lower socioeconomic status are more frequently taught by teachers with less pedagogical content knowledge and experience than their more affluent peers, which can influence their mathematics achievement (Darling-Hammond, 2010; Ko & Sammons, 2012).

Even before students enter high school and take the SAT, many students finish middle school unprepared for a challenging sequence of college-preparatory mathematics classes (Balfanz, McPartland, & Shaw, 2002). Schmidt and colleagues (1999) analyzed national and international comparisons of mathematics achievement, which indicated that between fourth and eighth grade U.S. students, especially students from a lower socioeconomic status, fall behind in mathematics proficiency. There are serious consequences when students are not meeting proficiency in mathematics by the end of the eighth grade (Balfanz & Byrnes, 2006). A student's success in rigorous college-preparatory mathematics classes in high school has been connected to success in postsecondary education and to lifelong opportunities (U.S. Department of Education, 1997).

In addition to the challenges posed by the mathematics achievement gap on students' kindergarten through twelfth grade educational career, students' socioeconomic status is also a predicator of whether they will succeed in majoring in a STEM field (Crisp et al., 2009; Niu, 2017; Seymour & Hewitt, 1997). Crisp and colleagues (2009) found a strong relationship between SAT mathematics scores on STEM enrollment. Furthermore, the positive relationship between SAT mathematics score and STEM enrollment becomes stronger with the increase a student's socioeconomic status (Crisp et al., 2009). Students with a higher level of mathematics achievement are more likely to succeed in STEM majors than those with a lower level of mathematics achievement (Seymour & Hewitt, 1997). Therefore, it is important to increase the mathematics achievement of students from a lower socioeconomic status to increase the likelihood of success in a STEM major.

Morgan, Farkas, Hillemeier, and Maczuga (2016) stress the importance of further investigating the mathematics achievement gap between socioeconomic statuses. There are limited longitudinal studies in the United States on the factors and consequences of the mathematics achievement gap (Morgan et al., 2016). There is a demand for further research on the mathematics achievement gap between students who receive free or reduced meal prices compared to their more affluent peers (Morgan et al., 2016).

Problem of Practice

Elementary school students who receive free or reduced meal prices underperform compared to their more affluent peers on standardized mathematics assessments (Gamoran & Long, 2006; Morgan, Farkas, Hillemeier, & Maczuga, 2016). Nationwide, the achievement gap in mathematics persists among students who receive free or reduced meal prices (Lee, 2006; Lee, 2012). For decades, the high school dropout rate continues to be higher for low-income families versus middle- and upper-class families (Cui, McFarland, Stark, National Center for Education Statistics, & American Institutes for Research, 2016). Further, there are disparities in college attainment and income levels of those who were identified with a low socio-economic status as children compared to their more affluent peers (Feinstein, Duckworth, & Sabates, 2008; Sackett, Kuncel, Arneson, Cooper, & Waters, 2009). The purpose of the No Child Left Behind Act of 2001 was to close the achievement gap, particularly in mathematics and reading, between disadvantaged students and their peers by the 2013-2014 school year, yet these gaps persist (Mehta, 2013). In particular, the mathematics achievement gap between students of varying socioeconomic groups at ABC Elementary School is prevalent.

ABC Elementary School is a suburban Title 1 school in Anne Arundel County, Maryland. At ABC Elementary School, student data reflects the national achievement gap among social classes. The recent fifth grade Partnership for Assessment of Readiness for College and Careers mathematics showed that only 17% of students who are receiving free or reduced meals met grade level *expectations* and 0% *exceeded expectations*, whereas 38% and 3% of their more affluent peers met or exceeded expectations, respectively.

Theoretical Framework

Bronfenbrenner (1979) developed the ecological systems theory (EST) to analyze children's relationships within their environments. The EST emphasizes the importance of interdependent systems on an individual's development. Traditionally, different levels of ecological systems are nested within one another. Within the concentric circles, the innermost circle focuses on the child through various microsystems. Microsystems are physical locations that include any individuals who have a direct relationship with the child, including home or school. Mesosystems contain interactions between microsystems such as the connection between a teacher and their student. Settings that have an indirect relationship on the child are included in the exosystem, such as the creation of educational policy. Furthest from the center, the macrosystems examine the influence of the societal environment on the child.

EST presents a systematic framework for exploring the factors associated with the achievement gap between students who receive free or reduced meal prices compared to their more affluent peers. Societal beliefs about people living in poverty and the stereotype threat are included in the analysis of the macrosystem. The exosystem includes the evaluation of the No Child Left Behind Act of 2001, the distribution of highly qualified teachers, and the Supplemental Nutrition Assistance Program. The importance of family-school partnerships will be examined in the mesosystem. Finally, the investigation of the microsystems includes the influences of teachers, families, and factors associated with the students themselves.

Factors Related to the Achievement of Lower-Income Students

This portion of the chapter will synthesize the literature related to the mathematics achievement gap between students who receive free or reduced meals compared to their more affluent peers. The synthesis will be organized by the EST framework (Bronfenbrenner, 1979). The EST framework provides the appropriate structure to critically analyze and reflect on the factors contributing to the mathematics achievement of low-income students. These related factors include beliefs about low-income students, policies and legislation, home-school partnerships, and factors related to teachers, families, and students.

Macrosystem

The macrosystem examines the influence of the societal environment on the child (Bronfenbrenner, 1979). Societal beliefs about low-income students may affect their academic achievement in mathematics (Croizet & Claire, 1998; Croizet & Dutrévis, 2004; Spencer & Castano, 2007). Furthermore, classroom teachers’ expectations of these students’ grades in mathematics class is a can be an indication of the students' achievement on standardized mathematics assessments (Petty, Wang, & Harbaugh, 2013).

Beliefs about low-income students. Among several other factors proposed to explain the mathematics achievement gap between those who qualify for free or reduced meal prices compared to their more affluent peers, societal beliefs and stereotypes about the ability of those earn a low-income influence their performance (Croizet & Claire, 1998; Croizet & Dutrévis, 2004; Spencer & Castano, 2007). Darley and Gross (1983) found a group of 67 undergraduate students from various socioeconomic statuses rated the academic ability of a child they assumed to be from a family with a high socioeconomic status to be above grade level. However, when the undergraduate students perceived the same child came from a family with a low socioeconomic status, they rated the child to be below grade level (Darley & Gross, 1983). Furthermore, Miller, McLaughlin, Haddon, and Chansky (1968) examined social class bias in teacher evaluations. The research suggests teachers display bias when approximating their students' abilities (Auwarter & Aruguete, 2008; Miller et al., 1968).

Teacher beliefs and bias about students from a lower socioeconomic status have the power to influence their students' achievement, specifically in mathematics (Petty, Wang, and Harbaugh, 2013). Teachers who believe that socioeconomic status is a predetermining factor for mathematics achievement, will likely feel ineffective when working with students from a lower socioeconomic status (Auwarter & Aruguete, 2008). A lower sense of self-efficacy can influence teachers' instructional practices and perpetuate low mathematics achievement for students from a lower socioeconomic status (Auwarter & Aruguete, 2008). In schools who serve mostly students from a lower socioeconomic status, approximately 75% of teachers have a low sense of self-efficacy (Warren, 2002). Furthermore, Petty and colleagues (2013) found that teacher expectations of students from a lower socioeconomic status plays a significant role in their mathematics achievement. By setting high expectations for all students, the teacher sends a message to their students that learning is the goal and that all students can learn (Petty et al., 2013). High teacher expectations and beliefs have been shown to affect reasoning skills frequently used in mathematics, more than verbal, memory, or motor skills (Petty et al., 2013). When a student was believed to have a low socioeconomic status, their academic ability and overall life attainment were believed to be lower than their more affluent peers (Auwarter, & Aruguete, 2008; Miller et al., 1968).

When societal beliefs develop into a stereotype about a particular group, the stereotype evolves into burden for the group's individuals that act as a threat to their performance (Croizet & Claire, 1998; Croizet & Dutrévis, 2004). A stereotype threat occurs when individuals of a stigmatized group perform poorly on an assessment because they fear confirming negative stereotypes that relate to their group (Croizet & Claire, 1998; Spencer & Castano, 2007). Situational pressure can intrude on the normal cognitive functioning of an individual and hinder his or her performance (Croizet & Dutrévis, 2004).

In threatening situations, stigmatized groups of students tend to underperform (Levens, Desert, Croizet, & Darcis, 2012). However, in nonthreatening situations stigmatized groups perform as well as their peers in nonthreatening situations (Leyens et al., 2012). Being evaluated in a threatening situation can cause the student to respond by lacking enjoyment, increasing stress and anxiety, and underperformance on assessments (Good, Aronson, & Inzlicht, 2003). When a stereotype is irrelevant to the situation, the stereotype does not undermine performance (Leyens et al., 2012) This is especially true for people from a low socioeconomic status (Croizet & Claire, 1998). Consequently, standardized assessments given in a threatening environment have a negative influence on students from stigmatized groups, resulting in the underperformance of these groups compared to their peers (Dennehy, Ben-Zeev, & Tanigawa, 2014; Spencer & Castano, 2007).

Exosystem

Environments with an indirect relationship on the child are included in the exosystem (Bronfenbrenner, 1979). The exosystem factors that may affect low income students' academic achievement include policy and legislation such as the influence of the No Child Left Behind (NCLB) Act of 2001. These factors include the influence of the distribution of highly qualified teachers, teacher resistance to change, and the Supplemental Nutrition Assistance Program.

Distribution of highly qualified teachers. The purpose of the NCLB Act included policies to address factors affecting student success (NCLB Act, 2001). One aspect of NCLB included hiring highly qualified teachers (NCLB Act, 2001), especially in Title I schools (Borman & Kimball, 2005). Although mixed results have been revealed, generally, teacher quality is positively correlated with academic achievement and is a predictor of student success (Mayer, Wiley, Wiley, Dees, & Raiford, 2016). The NCLB Act (2001) requires a highly qualified teacher in every classroom. However, the act allows each individual state to define a highly qualified teacher, with respect to requirements for certification. These characteristics relate to years of experience, level of education, and the passing of state licensure exams. Several research studies conducted to measure the effect teacher characteristics have on student achievement, show a teacher's number of years of experience has a positive correlation with student success (Goldhaber, Lavery, & Theobald, 2015; Rivkin, Hanushek, & Kain, 2005).

The NCLB Act (2001) requires states to ensure that marginalized children are not taught at higher rates than their peers by inexperienced, unqualified, or out-of-field teachers. Although many factors contribute to the achievement gap, policymakers have focused on teacher quality because it is the most important school factor in predicting academic achievement (Chetty, Friedman, & Rockoff, 2013; Rivkin et al., 2005). There is evidence that a teacher's classroom experience and quality, are unevenly distributed across various student subgroups (Goldhaber et al., 2015). The distribution of teacher quality is highly inequitable in ineffective schools with a lower socioeconomic status, compared to more affluent schools (Ko & Sammons, 2012). In urban, poor rural, and minority schools, there is a higher concentration of less qualified teachers (Darling-Hammond, 2010).

Teacher quality influences the improvement of low achieving students (Mincu, 2015). Teacher quality has the largest impact in elementary schools, where students spend most of the school day with a single classroom teacher (Mincu, 2015). Wiliam (2013) believes teacher quality may influence the achievement gap in elementary schools and effective teachers benefit students for at least two years after they have stopped teaching them. While teacher quality has little influence on student achievement in reading and spelling, teacher quality has a significant effect on students' mathematics achievement (Boonen, Van Damme, & Onghena, 2013; Mincu, 2015). Therefore, highly qualified mathematics teachers are essential for student from a lower socioeconomic status to progress (Mincu, 2012).

Teacher resistance to change. NCLB's purpose was to close the achievement gap between disadvantaged students and their peers (Thornburg & Mungai, 2011). The legislation placed emphasis on student achievement and accountability. Burke and Adler (2013) found well-intended mandates, such as NCLB, can have adverse effects which constrain teachers' ability to respond to the needs of their students while remaining in compliance. There is a consensus among educators and legislators that more effective teaching is needed to meet the needs of students with a low socioeconomic status, but there is not a consensus about how to meet this goal (Burke & Adler, 2013). The mandates' restriction on teachers' ability to make instructional choices within their classrooms has influenced teachers' resistance to change (Burke & Adler, 2013).

Thornburg and Mungai (2011) found teacher resistance increases when reform efforts affect classroom practices. Part of the issue for teachers may be the little consideration taken for teachers' perspectives on how to improve student success for their classes or how mandates drive reform efforts instead of their students' needs (Thornburg & Mungai, 2011). Educators who teach students from a low socioeconomic background are more likely to resist reform mandates (Thornburg & Mungai, 2011). Educators who teach students from a low socioeconomic status resist reform mandates because they are often accompanied by professional development that can take teachers away from valuable classroom instruction (Gitlin & Margonis, 1995; Margolis & Nagel, 2006).

Nutrition deficits. Financial instability limits families' access to proper nutrition (Frongillo, Jyoti, & Jones, 2006), which increases family stress and decreases students' cognitive functioning and reading and math achievement (Frongillo et al., 2006; Gershoff, Aber, Raver, &

Lennon, 2007; Gomez-Pinilla, 2008). Although nutritional programs like the Supplemental Nutrition Assistance Program (SNAP) aims to ameliorate nutrition deficits for low socioeconomic families, it is not sufficient. There are findings that SNAP benefits are insufficient for many families with a low socioeconomic status (Gassman-Pines & Bellows, 2018). Since SNAP benefits are only dispersed once a month, nutritional variability can hinder students' access to important nutrients. Vitamins and minerals found in whole grains, fruits and vegetables can improve cognitive (Cohen, Gorski, Gruber, Kurdziel, & Rimm, 2016; Gomez-Pinilla, 2008) and executive functioning skills necessary to be successful on standardized assessments (Cohen et al., 2016). These skills include cognitive processing, inhibitory control, working memory, attention, and planning (Cohen et al., 2016).

Limited access to proper nutrition influences parental stress (Gassman-Pines & Bellows, 2018). Parental stress over limited access to proper nutrition may be transferred to their children (Gassman-Pines & Bellows, 2018), causing challenges with children's externalizing behaviors (Conger & Donnellan, 2007). Limited proper nutrition is a barrier for these students to learn because of the decrease in cognitive and executive functioning through the periods of limited nutrition accessibility (Gassman-Pines & Bellows, 2018).

Mesosystem

Mesosystems contain interactions between microsystems (Bronfenbrenner, 1979). An example of a mesosystem is the connection between a teacher and their student (Bronfenbrenner, 1979). Factors within the mesosystem that may affect students' academic achievement include home-school partnerships and teacher-student relationships.

Home-school partnerships. The Coleman Report unveiled family background as an important factor of academic achievement (Coleman, Campbell, Hobson, McPartland, Mood, Weinfeld, & York, 1966). The most influential dimension of student success is the partnership between parents, students, and their school (Grace & Harrington, 2015; Matthews, McPherson-Berg, Quinton, Rotunda, & Morote, 2017). Parent involvement at school may include "attending parent-teacher conferences, attending programs featuring students, and engaging in volunteer activities (Lee & Bowen, 2006, p. 194). Parent educational involvement at home may include "providing help with homework, discussing the child's schoolwork and experiences at school, and structuring home activities" (Lee & Bowen, 2006, p. 194). The Elementary and Secondary Education Act (2001) identified the home-school partnership as a priority in education because it was beneficial for students, especially students with a low socioeconomic status.

Home-school partnerships and relations frequently affect educational outcomes more than factors connected with schools (Coleman et al., 1966; Ma, Shen, Krenn, Hu, & Yuan, 2016). Shaver and Walls (1998) found that strong home-school partnerships significantly influenced students' achievement in mathematics. A families' socioeconomic status influences their involvement in their child's education (Kuru Cetin & Taskin, 2016). When the home-school partnership is not strong, there is a negative influence on a student's mathematics achievement (Stright & Yeo, 2014). Desimone (1999) found a significant positive correlation between a family's socioeconomic status, the home-school partnership, and the student's mathematics achievement.

A strong home-school partnership is essential in urban schools to increase student achievement (Hoover-Dempsey, Bassler, & Brissse, 1992). A common misconception is that parents with a low socioeconomic status do not want to be involved with their child's education (Matthews, McPherson-Berg, Quinton, Rotunda, & Morote, 2017). Chavkin (1989) noted that poverty level parents want to be involved as much as non-poverty level parents in school activities and decision making; however, certain factors impede the parental involvement of families from impoverished backgrounds than those with a higher socioeconomic status. Certain cultural factors may hinder families with a lower socioeconomic status from feeling comfortable participating (Matthews et al., 2017). In addition, there is a large portion of families with a low socioeconomic status that do not have childcare to attend some of the school activities (Matthews et al., 2017).

Teacher-student relationships. A supportive teacher–student relationship is defined as "emotional accessibility and involvement [to] fulfill a basic psychological need and [to] promote self-determination" (Murray & Murray, 2004, p. 751). Positive teacher-student relationships are connected to a student's motivation and engagement in school activities (Durksen, Way, J., Bobis, Andersen, Skilling, & Martin, 2017; Goddard, Tschannen-Moran, & Hoy, 2001; Skinner & Belmont, 1993). Further, there is a positive relationship between academic achievement and the quality of the teacher-student relationship (Murray & Murray, 2004). Students with stronger academic abilities have closer, less conflicted relationships with their teachers (Ladd, Birch, & Buhs, 1999; Murray & Greenberg, 2000).

Students from a lower socioeconomic status more frequently attend schools with less qualified teachers (Rivkin et al., 2005). Additionally, these high-poverty schools tend to have a higher student-teacher ratio compared to more affluent schools (Rivkin et al., 2005). This creates a challenge for the teachers serving students from a lower socioeconomic status to build strong teacher-student relationships, which are linked to higher mathematics achievement (Chiu, 2010).

Microsystem

Microsystem factors that may affect students' mathematics academic achievement include teachers and family, in addition to the students themselves. Teacher factors include pedagogical content knowledge, self-efficacy, rate of attrition, and resistance to change. Family and student factors include parental level of schooling, beliefs about education, nutrition, homelessness, school mobility, and absenteeism.

Family and Student Factors

In the largest school systems in the United States, students with a low socioeconomic status face an increase in dropout rates and a decrease in parental involvement and resources (Gottfried, 2019). Klebanov, Duncan, and Brooks-Gunn (1994) found family income is an important factor in the physical environment and learning experience in the home. Smith, Brooks-Gunn and Klebanov (1997) found the connection between a family's socioeconomic status with their children's mathematics achievement was arbitrated by their home environment. Relatedly, students' parental level of schooling (Coleman et al., 1966; Cooper, Lindsay, Nye, & Greathouse, 1998; Grigg, Donahue, & Dion, 2007), homelessness status (Cutuli et al., 2013; Fantuzzo, LeBoeuf, Chen, Rouse, & Culhane; 2012), chronic absenteeism rate (Balfanz & Byrnes, 2006; Gottfried, 2014, 2019), and access to resources (Frongillo, Jyoti, & Jones, 2006; Gershoff, Aber, Raver, & Lennon, 2007; Gomez-Pinilla, 2008) have an influence on their mathematics achievement.

Parental level of schooling and beliefs about education. A child's family is a significant determinant of a child's academic success (Coleman et al., 1966; Campbell, Hombo & Mazzeo, 1999; Sharma & Jha, 2014). Parental level of schooling is a powerful predictor of socioeconomic status (Bahr, 2010). Typically, students with a higher socioeconomic status have parents with some form of postsecondary education (Bers, 2005). A parent's level of schooling is considered one of the most important factors in predicting student achievement (Klebanov, Brooks-Gunn & Dunkan, 1994; Houston & Xu, 2016; Smith, Brooks-Gunn & Klebanov, 1997). In addition, a parent's level of schooling influences the beliefs of the parent, which consequently has a positive impact on their children (Klebanov et al., 1994). In particular, a mother's level of schooling has a stronger correlation with parental warmth (Klebanov et al., 1994), a child's cognition, and behavior (Corwyn & Bradley, 2002; Rhea & Otto, 2001).

Sharma and Jha (2014) posits that children with highly educated parents are more likely to provide a more supportive home environment compared to students with less educated parents. They may provide better resources like books, coaching, which positively impact children's academic success (Klebanov et al., 1994; Sharma & Jha, 2014). A parents' education may assist a parent in becoming a more effective support system at home because they are more likely to know more about what their children are being taught in the classroom and are able to help their child with homework (Klebanov et al., 1994; Sharma & Jha, 2014).

Furthermore, parents' level of education is positively correlated with mathematics performance (Grigg et al., 2007). Parents' level of education may influence their child's mathematics achievement as a consequence of the parents' capability to assist with homework assignments (Cooper et al., 1998). Matthews and Farmer (2008) posit that parental involvement in their children's mathematics assignments makes children more likely to enroll in challenging mathematics classes such as Algebra I at an earlier stage in their academic career (U.S. Department of Education, 1997). Parental level of education has a small effect on mathematical reasoning, which has a moderate effect on Algebra I achievement (Matthews & Farmer, 2008). This finding aligns with the previous studies conducted on the influence of parents' level of education on academic achievement (Grigg et al., 2007).

Homelessness and school mobility. Homelessness can influence students' engagement in the classroom and their academic achievement (Fantuzzo et al., 2012). Homelessness is defined as "a severe form of residential instability" (Fantuzzo et al., 2012, p. 393) and is more likely to occur among families with young children and a low socioeconomic status (Fantuzzo et al., 2012). Young children experiencing homelessness are more likely to go through unexpected school transfers (Buckner, Bassuk, & Weinreb, 2001; Howland, Chen, Chen, & Min, 2017) which influences students' standardized assessment scores (Mantzicopoulos & Knutsen, 2000; Xu, Hanaway, & D'Souza, 2009). Furthermore, this negative correlation between school mobility and mathematics achievement is more detrimental to students who transfer within large urban districts (Hanushek, Kane, & Rivkin, 2004; Reynolds, Chen, & Herbers, 2009). Young children experiencing homelessness are also more likely to have poor attendance (Fantuzzo & Perlman, 2007; Zima, Bussing, Forness & Benjamin, 1997). In addition to the homelessness status (Fantuzzo et al., 2012), poor attendance can also have a negative impact on a student's academic success (Gottfried, 2014a).

School mobility has a negative influence on mathematics and reading assessment scores (Mantzicopoulos & Knutsen, 2000; Xu, Hanaway, & D'Souza, 2009), an increase in behavior problems (Gruman, Harachi, Abbott, Catalano, & Fleming, 2008; Tucker, Marx, & Long, 1998), and higher probability of being held back (Simpson & Fowler, 1994; Tucker et al., 1998). The negative correlations between school mobility and academic achievement are more prominent among students from large urban school districts (Hanushek, Kain, & Rivkin, 2004). Cutuli and colleagues (2013) found that students who are experiencing homelessness or high mobility show significantly lower achievement in mathematics on average than students from more affluent groups and this achievement continues to widen over time. Further, students receiving free or reduced meals underperform in mathematics compared to students who do not receive free or reduced meals (Cutuli et al., 2013). Additionally, the year after students have been identified as experiencing homelessness or highly mobile, the growth rate for mathematics decreases, but the growth rate for reading does not (Cutuli et al., 2013).

Absenteeism. Balfanz and Byrnes (2012) define chronic absenteeism as missing approximately 10% of the school year. By this definition, between 10% and 15% of students in the United States would fit this criteria (Gottfried, 2019). Nationwide, this rate of chronic absenteeism is more prevalent in urban school districts (Nauer, Mader, Robinson, & Jacobs, 2014). Further, it is more prevalent in elementary school than in middle and high schools, especially in urban school districts (Balfanz & Byrnes, 2012; Chang & Romero, 2008; Romero & Lee, 2007). This relationship is exemplified for students as early as kindergarten. Therefore, early learners in urban elementary schools are most at risk. According to Gottfried (2014a) chronic absenteeism for these students is negatively correlated with students' academic success.

Chronic absenteeism has an impact on the individual student and on the entire class (Gottfried, 2019). Students experiencing chronic absenteeism receive fewer hours of classroom instruction and require remediation upon returning to school from on absence (Balfanz & Byrnes, 2018; Chen & Stevenson, 1995). In addition, chronic absenteeism can cause students to feel withdrawn from their classmates and teachers and may consequently have a negative impact on their interactions with one another (Gottfried, 2014b). While teachers are spending their limited time and attention on students experiencing absenteeism, the other students are not receiving the same pace of instruction and attention from their teacher (Gottfried, 2019).

Balfanz and Byrnes (2006) explored factors that had the potential to close the mathematics achievement gap in urban schools, among those was attendance. Students who were chronically absent had lower achievement outcomes in mathematics than those students who were not chronically absent (Gottfried, 2014a). Although there is a negative relationship between chronic absenteeism and both reading and mathematics achievement, the effect sizes are slightly larger in the models predicting mathematics achievement (Gottfried, 2014a). Mathematics achievement tends to be more influenced by classroom presence, since reading is a subject more frequently supported at home (Gottfried, 2014a).

Teacher Factors

Students with a lower socioeconomic status are more likely to have less experienced teachers (Ko & Sammons, 2012). Ball, Hill, and Bass (2005) posit that teachers who serve students from a lower socioeconomic status tend to have a lower level of pedagogical content knowledge in mathematics. Additionally, teachers who serve students from a lower socioeconomic status generally have a lower sense of self-efficacy (Althauser, 2015). Both factors can have a negative impact on students' mathematics achievement, especially for those from a lower socioeconomic status. Furthermore, schools serving higher levels of students from a lower socioeconomic status are more likely to have higher rates of teacher attrition which can influence students mathematics achievement (Borman & Kimball, 2005; DeAngelis & Presley, 2011; Jacob, Vidyarthi, & Carroll, 2012).

Teacher pedagogical content knowledge. Traditional methods of improving American instructional quality have been to create a rigorous and effective curriculum, however, "no curriculum teaches itself, and standards operate independently of professionals' use of them" (Ball, Hill, & Bass, 2005, p. 15). Shulman (1987) defines pedagogical content knowledge as "that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding" (p. 8). Teachers are charged with the responsibility to deeply understand the content in their curriculum in multiple representations and transform the content knowledge into an effective form for students to grasp. An effective teacher must possess the skills to adapt and tailor their instruction to meet the needs of their students. When pedagogical content knowledge is lacking, teachers tend to change their instruction to alleviate their anxiety, instead of meeting the instructional needs of their students.

Ball, Hill, and Bass (2005) found a correlation between teachers' pedagogical content knowledge and student socioeconomic status. Teachers of students living in high poverty are more likely to have teachers with less mathematical knowledge compared to their more privileged peers (Ball et al, 2005). Teachers' pedagogical content knowledge in mathematics is significantly associated with student mathematic achievement (Olfos, Goldrine, & Estrella, 2014). A teacher's pedagogical content knowledge alone could not solely overcome the mathematics achievement gap, however, it could prevent that gap from increasing over time (Ball et al., 2005).

An aspect of teachers' pedagogical content knowledge in mathematics is their ability to elicit higher level thinking skills from their students (McGatha, Bay-Williams, Kobett, & Wray, 2018). Bloom's taxonomy is a well-known framework for identifying the level of cognitive demand of questions (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). Most questions posed by teachers do not induce students' high level of thinking (McGatha et al., 2018). The Mid-continent Research for Education Learning (2009) found that 60% of questions asked by teachers were at the lowest levels of Bloom's Taxonomy, knowledge and comprehension. According to McGatha, et al. (2018), posing higher level questions is a part of classroom discourse to engage student participation in increasing their mathematical understanding. Further, a well-developed question, evokes important mathematical thinking and discussion.

Teacher self-efficacy. Albert Bandura (1997) defined teacher self-efficacy as "beliefs in one's capacity to organize and execute the courses of action required to produce given attainments" (p. 3). A teacher's self-efficacy influences the effort they put into professional practice, their goals, and their aspirations (Bandura, 1977). When challenges arise, a teacher's self-efficacy can affect their tenacity and perseverance (Tschannen-Moran & Hoy, 2001). A teacher with high self-efficacy can work diligently with struggling students rather than simply giving them the correct answers (Gibson & Dembo, 1984). A teacher's self-efficacy to educate students are significantly and positively correlated to teacher behaviors that support student success (Goddard & Goddard, 2001; Muijs & Reynolds, 2002).

Althauser's (2015) research showed a relationship between a teacher's sense of self-efficacy and the mathematics achievement of students with a low socioeconomic status. Althauser (2015) uses a student's free or reduced meal status to measure their socioeconomic status. In this study, a teacher's general efficacy and their students' free or reduced meal status had a significant relationship with their students' mathematics achievement. The most powerful predictor of their students' mathematics achievement was the students' free or reduced meal program status. There was a direct relationship between their students' socioeconomic status and mathematics achievement. Furthermore, the second most powerful predictor of their students' mathematics achievement was the teachers' general efficacy in teaching mathematics. Althauser (2015) found a direct relationship between the teachers' general efficacy and their students' mathematics achievement.

Mathematics self-efficacy. Mathematics teachers' self-efficacy beliefs can influence their instructional practices (Wilhelm & Berebitsky, 2019). Teachers with a higher level of self-efficacy in teaching mathematics have some varying characteristics compared to those with a lower sense of self-efficacy (Nurlu, 2015). The characteristics of a highly efficacious teacher of mathematics includes showing a higher level of persistence with their students, being open to new ideas and instructional practices, believing in their students' abilities, and placing more emphasis on building a strong relationship with their students (Nurlu, 2015). Mathematics teachers with a higher sense of self-efficacy help students, including those who first had a negative attitude towards learning mathematics, accomplish high-achieving mathematics standards (Vinson, 2001).

Teachers who have a lower sense of self-efficacy in teaching mathematics tend to blame student and parent factors to explain why students are failing, instead of teacher characteristics such as their teaching methods and their ability to build a relationship with their students (Nurlu, 2015). Generally, teachers with a lower sense of self-efficacy do not feel responsible for improving their practice which could influence their students' achievement in mathematics (Nurlu, 2015). As such, mathematics teachers' self-efficacy beliefs have the power to affect their students' mathematics performance.

Teacher attrition. Researchers have devoted a tremendous amount of time studying teachers because they are the key factor correlated with student achievement (Hochbein & Carpenter, 2017). There is a connection between a school's student population and the teacher attrition rate (Hochbein & Carpenter, 2017). Research studies have consistently shown high needs schools with low test scores and large proportions of minority and students from a lower socioeconomic status, have higher rates of teacher attrition (Borman & Kimball, 2005; DeAngelis & Presley, 2011; Jacob, Vidyarthi, & Carroll, 2012). Ritchie (2004) found that many researchers have analyzed individual characteristics of teachers and schools to explain teacher migration.

Keigher and Cross (2010) estimated in the 2008-2009 academic year, approximately 500,000 teachers in the United States left their schools. Of those teachers, 255,700 left their position to seek employment at another school (Keigher & Cross, 2010). Among the factors studied are the quality of the teachers' preparation (Darling-Hammond, Berry, & Thoreson, 2001; Goldhaber & Brewer, 2000), gender, race/ethnicity, subject specialization, route to certification, and familial obligations (Borman & Dowling, 2008; Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2006; Ingersoll, 2001; Kirby, Berends, & Naftel, 1999; Stinebrickner, 2002). Teachers with less than two years of teaching experience have higher rates of attrition compared to their more experienced peers (Hanushek et al., 2004). Administrative actions, attitudes, and support on student discipline, autonomy, and compensation are factors associated with teacher attrition (Barnett & McCormick 2004; Griffith, 2004; Hanushek, Kain, & Rivkin, 2004; Ingersoll, 2001).

Furthermore, there is increasing evidence that urban areas with less effective teachers are often concentrated in lower-performing schools with students from a lower socioeconomic status, which has a negative influence on students' mathematics achievement (Adnot, Dee, Katz, & Wyckoff, 2017). Adnot and colleagues (2017) define high-performing mathematics teachers as teachers who were rated as "effective" and "highly effective." Teacher attrition has a negative relationship with students' mathematics achievement due to the challenges of replacing experienced mathematics teachers (Adnot et al., 2017). In a school serving students from a lower socioeconomic status, replacing a high-performing mathematics teacher is estimated by Adnot and colleagues (2017) to result in a decrease of 80% of a standard deviation of teacher quality in mathematics.

Conclusion

After reviewing the literature related to the achievement gap, specifically in mathematics, between students who receive free or reduced meal prices compared to their more privileged peers, contributing factors included beliefs about low-income students (Croizet & Claire, 1998; Croizet & Dutrévis, 2004; Spencer & Castano, 2007); policies and legislation (NCLB Act, 2001); relationships between home, school and students (Coleman et al., 1966); and factors relating to teachers (Ball et al., 2005), families (Campbell, Hombo & Mazzeo, 1999; Sharma & Jha, 2014) and students (Fantuzzo et al., 2012). When a stereotype exists among the general population about a stigmatized group, it can develop into a threatening situation for the group member and consequently cause these students to underperform (Croizet & Claire, 1998; Croizet & Dutrévis, 2004). A highly qualified teacher is an asset in challenging schools where stereotype threats exist; however, highly qualified teachers are inequitably distributed between urban and more affluent school districts (Ko & Sammons, 2012).

In addition to factors associated with school, a family's ability to provide proper nutrition can influence students' cognitive functioning and standardized assessment scores (Frongillo et al., 2006; Gershoff et al., 2007; Gomez-Pinilla, 2008). Finally, one of the most significant factors in student mathematics achievement is the relationship between parents, students, and their school (Coleman, 1966; Desimone, 1999; Grace & Harrington, 2015; Shaver & Walls, 1998; Stright & Yeo, 2014).

Family and student factors impacting the mathematics achievement gap between students receiving free or reduced meal prices and their more affluent peers include parental level of schooling, (Cooper et al., 1998; Grigg et al., 2007; Houston & Xu, 2016; Klebanov et al., 1994; Smith et al., 1997), homelessness (Cutuli et al., 2013; Fantuzzo et al., 2012; Hanushek et al., 2004), and absenteeism (Balfanz & Byrnes, 2006; Gottfried, 2014a). A parent's level of schooling is related to a family's socioeconomic status and is recognized as one of the most critical factors in predicting academic achievement (Klebanov et al., 1994; Smith et al., 1997). A struggling family experiencing homelessness can impact students' attendance (Fantuzzo & Perlman, 2007; Zima et al., 1997), engagement in the classroom and their academic success

(Fantuzzo et al., 2012). In addition, Gottfried (2014a) found a negative correlation between chronic absenteeism and students' mathematics achievement.

Finally, teachers' pedagogical content knowledge (Ball et al., 2005; Shulman, 1987), self-efficacy (Bandura, 1977; Bandura, 1997; Gibson & Dembo, 1984; Goddard & Goddard, 2001; Muijs & Reynolds, 2002; Tschannen-Moran & Hoy, 2001), and rate of attrition (Althauser, 2015; Hochbein & Carpenter, 2017) can influence students' mathematics achievement. Since teacher quality has the largest impact on students in elementary school (Mincu, 2015) and teacher-student relationships influence a student's motivation and engagement in school activities (Goddard, Tschannen-Moran, & Hoy, 2001; Skinner & Belmont, 1993), the needs assessment will focus on factors associated with teachers. Teachers' pedagogical content knowledge and self-efficacy will drive the comprehensive needs assessment. Aligning the previous research with the data collected from the needs assessment will guide the planning of an intervention for closing the mathematics achievement gap between students who receive free or reduced meal prices and their more affluent peers.

CHAPTER 2

Needs Assessment

Elementary school students who receive free or reduced meal prices underperform compared to their more affluent peers on mathematics standardized assessments (Gamoran & Long, 2006; Morgan et al., 2016). Nationwide, the achievement gap persists in reading and in mathematics among K-12 students who receive free or reduced meal prices (Lee & Harvard Civil Rights Project, 2006) and has implications on the high school dropout rate. A factor influencing the high school dropout rate is the inequitable distribution of teacher quality in struggling schools serving students from a lower socioeconomic status (Fettler, 2001; Ko & Sammons, 2012). Mathematics teachers' education and years of experience have a negative relationship with the high school dropout rate (Fettler, 2001). Therefore, schools serving students with a lower socioeconomic status with less educated and less experienced mathematics teachers, tend to have a higher dropout rates (Fettler, 2001). Further, there are disparities in college attainment and income levels of those who were identified with a low socio-economic status as children compared to their more affluent peers (Feinstein, Duckworth, & Sabates, 2008; Sackett, Kuncel, Arneson, Cooper, & Waters, 2009).

The purpose of the No Child Left Behind Act of 2001 was to close the achievement gap between disadvantaged students and their peers by the 2013-2014 school year, yet the achievement gap persists (Mehta, 2013). At ABC Elementary School, student data reflects the national achievement gap among socioeconomic classes. Recent third-grade mathematics scores on the Partnership for Assessment of Readiness for College and Careers standardized assessment showed that 19.3% of students who are receiving free or reduced meals *met grade* *level expectations* and 1.8% *exceeded expectations*, whereas 24% and 5.2% of their more affluent peers met or exceeded expectations, respectively. ABC Elementary School's data reflects the data collected at the state level. Maryland's third-grade mathematics scores on the Partnership for Assessment of Readiness for College and Careers standardized assessment showed that 21.1% of students who are receiving free or reduced meals *met grade level expectations* and 3% *exceeded expectations*, whereas 32.4% and 10.1% of their more affluent peers met or exceeded expectations, respectively (Maryland State Department of Education, 2019).

A review of the literature unveiled the factors linked to the achievement gap between elementary students who receive free or reduced meal prices and their more affluent peers in mathematics. Students with a lower socioeconomic status have a higher percentage of less qualified teachers across school districts (Adamson & Darling-Hammond, 2012; Borman & Kimball, 2005; Choi, 2010; Fuller & Ladd, 2013; Han, 2018; Schultz, 2014). Under the No Child Left Behind Act of 2001, an elementary school teacher is considered highly qualified with a "full state certification as a teacher; a minimum of a bachelor's degree obtained from an accredited institution of higher education; and subject knowledge and teaching skills in reading, writing, mathematics, and other areas of the basic elementary school curriculum as demonstrated by passing a rigorous state test" (Schultz, 2014). However, urban school-teacher attrition (Hochbein & Carpenter, 2017) and teacher resistance to implement effective practices (Burke & Adler, 2013; Thornburg & Mungai, 2011) influence student performance. Family and student factors include their beliefs and how they value education (Mayo & Siraj, 2015), absenteeism (Gottfried, 2019), and access to resources (Gassman-Pines & Bellows, 2015). This study will focus on teacher factors associated with the mathematics achievement gap. Of the teacher factors, qualitative and quantitative data will be collected on teacher self-efficacy and pedagogical content knowledge in mathematics.

Context of the Study

The context of the study is an open-space elementary school located in Anne Arundel County, Maryland. An open-space school contains no walls to separate classrooms. ABC Elementary School services students from pre-kindergarten through fifth grade. There are currently 635 students enrolled within the 29 classrooms (ABC Elementary School Records, 2019). ABC Elementary School is a Title I school because 60.47% of the students receive free or reduced meal prices (ABC Elementary School Records, 2019). Title I "provides financial assistance to local educational agencies (LEAs) and schools with high numbers or high percentages of children from low-income families to help ensure that all children meet challenging state academic standards" (United States Department of Education, 2018). ABC Elementary School has been labeled as academically challenged because of the low standardized assessment scores for the past three school years. With Title I funds, ABC Elementary School has hired two mathematics resource teachers, three instructional support teachers, and one teaching assistant. ABC Elementary School receives extra funding for two behavioral interventionist positions to support students with emotional challenges.

Students qualify for free or reduced meal prices through the completion of an online application. Historically, a paper application was sent home with all students on the first day of school and an online version of the paper form was offered (Anne Arundel County Public Schools, 2015). However, the online application is more efficient and is offered in multiple languages (Anne Arundel County Public Schools, 2015). Paper applications are available in limited quantities if a family does not have access to technology (Anne Arundel County Public Schools, 2015). A student's eligibility is based on the household size and household income (Anne Arundel County Public Schools, 2015). All children in households receiving benefits from the Food Supplement Program, or Temporary Cash Assistance, foster children, children certified as homeless, runaway or migrant can receive free meals regardless of their household income (Anne Arundel County Public Schools, 2015). The poverty line changes from year to year and is determined by the federal income eligibility guidelines (United States Department of Education, 2018).

Statement of Purpose

As the literature reveals, the influence of a teacher's self-efficacy and their pedagogical content knowledge is complex. To further understand the complicated factors in the achievement gap between students who receive free or reduced meal prices compared to their more affluent peers, a mixed-methods research design is used to determine the influence of teachers' self-efficacy and pedagogical content knowledge on student performance on standardized mathematics assessments in first and second grade.

Research Design

This needs assessment study was conducted using a mixed methods research design to gather various qualitative and quantitative data to appropriately answer all research questions. The definition of mixed methods suggested by Creswell and Plano-Clark (2018) incorporated diverse perspectives and combined methods, research design and philosophy orientation. In this mixed methods study, the researcher collected and analyzed both qualitative and quantitative data strands using a convergent design (Creswell & Plano-Clark, 2018). A convergent parallel research design is a mixed methods design which allowed the researcher to collect and analyze qualitative and quantitative databases, then merge the data to compare and/or combine the results (Creswell & Plano-Clark, 2018). The triangulation of multiple data sources ensured credibility, reliability, and validity between all data sources (Lochmiller & Lester, 2017). A mixed methods research design allowed for an in-depth analysis that relied on the merging of qualitative and quantitative data (Creswell & Clark, 2017).

To satisfy the research purpose for this study, four research questions guided the inquiry of the contributing factors of the mathematics achievement gap between students who receive free or reduced meal prices compared to their more affluent peers. The research questions included the following:

RQ1: What mathematics pedagogical content knowledge do first and second grade teachers exhibit in their classrooms?

RQ2: How do first and second grade teachers' pedagogical content knowledge in mathematics influence students' mathematics achievement?

RQ3: What are teachers' levels of self-efficacy?

RQ4: To what extent does teacher self-efficacy influence student achievement in mathematics?

Method

A convergent mixed method research design was implemented for the needs assessment (Creswell & Clark, 2018). The quantitative and qualitative data were collected simultaneously and triangulated. The qualitative observations provided an in-depth explanation for the quantitative gathered by the Teacher Efficacy Scale (Gibson & Dembo, 1984), the Measuring Content Knowledge for Teaching Mathematics (MKT) instrument (Hill, Schilling, & Ball, 2004), and the standardized mathematics assessment data.

Participants

At ABC Elementary School, there are 28 pre-kindergarten through fifth grade classroom teachers (ABC Elementary School Records, 2019). Twenty-six classroom teachers are Caucasian females and two are Caucasian male teachers. There are 13 classroom teachers with less than five years of teaching experience, eight of which are non-tenured (ABC Elementary School Records, 2019). For this context, non-tenured teachers are those with less than three years of effective teaching experience based on formal observations conducted by their administrators.

A convenience sampling method was used to engage teachers who were accessible to the researcher (Lochmiller & Lester, 2017). The professional role of the participants is a classroom teacher. The respondents are appropriate to examine my problem of practice because they have a direct relationship with students and are a key factor in students' mathematics achievement. In compliance with the Homewood Institutional Review Board (HIRB), potential respondents were directly approached in person by the researcher for recruitment. Further, prior to participating, teachers provided their consent by signing an approved IRB consent form. The research study does not include children as a primary data source; however, existing student assessment data was analyzed as a secondary data source. All student names were de-identified to provide confidentiality and anonymity, in compliance with the EdD Needs Assessment IRB.

Of the potential respondents, seven (71.43%) of the nine classroom teachers accepted the request to participate in the research study. The participants are four first- and three second-grade classroom teachers, who all teach mathematics (Table 2.1). All participants are Caucasian females. Four (57.14%) of the seven participants are non-tenured teaches. The participants' percentage of students receiving free or reduced meal prices ranged from 40%-50% to 60%-70% in their classroom. The participating teachers' experience ranged from one to eight years. The mean number of years of teaching experience is three years (M=3.43). Three (42.86%) of the seven participants are first year teachers and have only taught second grade. Five (71.43%) of the seven teachers have only taught one grade level. The other two teachers (28.57%) have taught at least one other grade level in the elementary school setting. The participating first grade teachers' teaching experience ranged from three to eight years. The other three respondents were first year, second grade teachers.

Table 2.1

Teacher Descriptives

Participant	Grade Level	Tenure Status	FARM Percentage	Years of Teaching Experience
1	1st	Not tenured	60-70%	3
2	1st	Tenured	50-60%	4
3	1st	Tenured	60-70%	8
4	1st	Tenured	60-70%	6

5	2nd	Not tenured	40-50%	1
6	2nd	Not tenured	50-60%	1
7	2nd	Not tenured	50-60%	1

Measures or Instrumentation

The purpose of the instruments used in this needs assessment study are to collect data on teacher's self-efficacy, pedagogical content knowledge, and mathematics achievement. Classroom observations and the Measuring Content Knowledge for Teaching Mathematics (MKT) instrument (Appendix A) will measure each teacher's pedagogical content knowledge in mathematics (Hill et al., 2004). The Teacher Efficacy Scale (Appendix B) will measure each teacher's beliefs about their ability to affect mathematics outcomes. Mathematics achievement is measured through standardized mathematics assessment data.

Pedagogical content knowledge. Classroom observations of mathematics lessons and the MKT instrument (Appendix A) were conducted to measure each teacher's pedagogical content knowledge (Hill, Ball, Schilling, 2004). Pedagogical content knowledge is defined as "that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding" (Shulman, 1987, p. 8).

Observation. The researcher conducted non-participant observations and minimized their interactions with the participants (Lochmiller & Lester, 2017). The observational protocol provided a useful method to organize the observational data (Creswell & Plano-Clark, 2018)

(Appendix C). Field notes were recorded as verbatim transcripts. Each participant was observed for one mathematics lesson. Each mathematics lesson was approximately one hour in length.

MKT. The researcher participated in the required training to appropriately administer the instrument and analyze the data correctly. The researcher conducted a survey using the MKT instrument (Appendix A) to measure each teacher's pedagogical content knowledge. The MKT instrument contains a section on number concepts and operations and another section on geometry. On this survey, participants answered 28 or 29 multiple choice questions on number concepts and operations and either 19 or 23 questions on geometry, depending on the form they were randomly assigned. For the portion on number concepts and operations, Form A had 28 questions and Form B had 29 questions. For the portion on geometry, Form A had 19 questions and Form B had 23 questions. Examples from this survey include "Which of the following is the best explanation for why the conventional long division algorithm works, as in the example below?" and "As her students got out their materials, they began to discuss ways to represent 12.4. Which of the following representations should the class accept as correct?" Hill and colleagues (2004) used coefficient alphas for a classical test theory measure of reliability and Item Response Theory reliabilities computed using BILOG software. The reliabilities for each of the scales, as well as for scales that combined number and operations items within each domain, were good to excellent, with a range from 0.71 to 0.84 (Hill et al., 2004).

Teacher self-efficacy. The 30-item Teacher Efficacy Scale (Appendix B) is an existing survey (Gibson & Dembo, 1984). The survey was designed to measure each teacher's beliefs about their ability to affect achievement. Teacher self-efficacy is defined as "beliefs in one's capacity to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3). On this survey, participants respond by indicating their self-efficacy about teaching by using a six-point Likert scale ranging from 1 *strongly disagree* to 6 *a strongly agree.* Examples from this survey include "When a student does better than usual, many times it is because I exerted a little extra effort" and "I have enough training to deal with almost any learning problem." An analysis of reliabilities yielded Cronbach's alpha coefficients resulted in .78 for the Personal Teaching Efficacy factor, .75 for the Teaching Efficacy factor, and .79 for all the items (Gibson & Dembo, 1984) (Appendix B).

Mathematics achievement. In this study, mathematics achievement was measured through mathematics assessment data including two county-wide, standardized Checkpoint Assessments for first grade and one county-wide, standardized Checkpoint Assessment for second grade. A team of the district's classroom and resource teachers work collaboratively to create the Checkpoint Assessments. Prior to completion, the assessments go through a vetting process with another group of classroom teachers, school mathematics leaders, Title I mathematics teachers and resource teachers. The Administrator of Account Data ensures these assessments are valid and reliable. Through the analysis, the administrator and the mathematics department to determine which questions are not valid and/or reliable to edit and improve the assessment.

One of the first grade Checkpoint Assessments has six questions and the other has seven questions. Both first grade Checkpoint Assessments assess students' ability to add; subtract; and organize, represent, and interpret data. In addition to these content standards, Checkpoint Assessment 7 assesses students' ability to measure the length of an object and Checkpoint Assessment 8 assesses their ability to tell time. Both assessments contain initiate-response-feedback (IRF) and focusing questions. An example of an IRF question is "How many toys are on the shelf in all?" (Anne Arundel County Public Schools Blackboard, 2019). An example of a focusing question is "How did you solve 35+46 using place value understanding?" (Anne Arundel County Public Schools Blackboard, 2019).

The second grade Checkpoint Assessment 7 has seven questions. The Checkpoint Assessment 7 assesses students' ability to add; subtract; tell time; determine if a number is even or odd; and organize, represent, and interpret data. The assessment contains IRF and focusing questions. An example of an IRF question is "How many more students chose chocolate than strawberry?" (Anne Arundel County Public Schools Blackboard, 2019). An example of a focusing question is "Show and solve 568-373." (Anne Arundel County Public Schools Blackboard, 2019).

Procedure

This section discusses the data collection methods for each instrument used in the needs assessment. Additionally, this section also outlines the necessary data analysis techniques used by the researcher to properly answer the research questions.

Data Collection

Pedagogical content knowledge. During April and May of 2019, the researcher conducted classroom observations during mathematics instruction from all seven participants. All seven (100%) participants agreed to be observed. The classroom observations lasted between 45 and 60 minutes each. Field notes were taken to capture the activity in the classroom. In May, an online version of the MKT instrument was conducted with all seven (100%) of the research participants. Teachers were informed to try their best and they were not expected to answer all questions accurately.

Teacher self-efficacy. A paper version of the 30-item Teacher Efficacy Scale was administered to all nine research participants. The survey was distributed in person and was anonymously submitted to maintain confidentiality. As the participants' mathematics resource teacher, teachers were requested to answer questions honestly by explaining the purpose of the needs-assessment was to collect data on factors influencing the achievement gap between social classes. Of the seven participating classroom teachers, all seven (100%) responded to the survey.

Mathematics achievement. Existing standardized assessment data was collected to measure mathematics achievement. A mathematics resource teacher was requested to access the data through Performance Matters. Performance Matters is a database that stores all assessment data in all content areas across the district. The mathematics resource teacher downloaded the mathematics assessment data into an excel spreadsheet to de-identify the data to ensure confidentiality.

Data Analysis

Quantitative analysis. Mixed methods data analysis methods were used to appropriately answer the research questions. To analyze the quantitative data from the Teacher Efficacy Scale, descriptive statistics, including mean and range were computed. The standardized mathematics achievement scores were disaggregated and compared between students who receive free or reduced meal prices compared to their more affluent peers.

Descriptive statistics including mean and mean differences were computed to compare mathematics achievement between students who receive free or reduced meal prices compared to students who do not.

Qualitative analysis. To analyze the qualitative classroom observation data, descriptive coding and a priori coding was used to identify codes, categories, and themes related to teachers' pedagogical content knowledge in mathematics (Lochmiller & Lester, 2017). Descriptive and a priori codes were used to identify words or phrases to segment the data and to develop themes (Lochmiller & Lester, 2017). Descriptive codes give meaning to the data by describing, in a word or two, the main idea of the qualitative data (Lochmiller & Lester, 2017), while a priori codes are "predetermined words or phrases that are directly linked to the research literature" (Lochmiller & Lester, 2017, p. 175).

Researcher positionality and trustworthiness*.* The researcher's position within the context is a non-evaluative, Title I mathematics teachers whose main role is the professional development of teachers. Since the researcher is working alone and has spent ample time in the field, this can lead to biased observations and inferences on the case and the researcher (Miles, Huberman, & Saldana, 2014).

To strengthen the trustworthiness of the data analysis process, the researcher used member checking by requesting the participants read over their transcript to ensure the transcription accurately represented the observation of the mathematics lesson (Creswell & Plano Clark, 2018). Once the participants agreed the transcripts were accurate reflections of the mathematics lesson observed, the researcher commenced the descriptive and a priori coding process. First, each transcript was read multiple times and overall impressions were noted (Lochmiller & Lester, 2017). Then, codes were assigned to the text. Next, the codes were organized into common themes related to each research question.

Merged analysis. Finally, the quantitative data from the Teacher Efficacy Scale, the MKT instrument, and the standardized mathematics assessments with the qualitative data from the classroom observations were analyzed to appropriately answer the research questions. For example, the researcher compared the teacher data collected from the Teacher Efficacy Scale and MKT instrument and to the student data from the standardized mathematics assessments to identify any connections or trends.

Findings and Discussion

RQ1: What mathematics pedagogical content knowledge do first and second grade teachers exhibit in their classrooms?

To respond to the first research question, the classroom observations in mathematics were analyzed using descriptive and a priori coding. The descriptive and a priori codes were used to develop the theme of questioning from the data (Lochmiller & Lester, 2017) (Table 2.2). The classroom observational data indicated a varying ability level in teachers' pedagogical content knowledge. Unfortunately, most questions asked by teachers did not elicit higher level thinking skills from students (McGatha, Bay-Williams, Kobett, & Wray, 2018).

Sixty percent of questions posed by teachers were at the two lowest levels of Bloom's Taxonomy, knowledge/remembering and comprehension/understanding (Mid-continent Research for Education and Learning, 2009). The data collected during the needs assessment reflected the same trend, 77.48% of the questions posed by teachers elicit lower levels of critical thinking. Developing high-level questions can develop a deeper understanding of student content knowledge, but this level of questioning requires preplanning on the part of the teacher (McGatha et al., 2018). Planning for high level questioning is time consuming, however, it promotes students' abilities to apply, analyze, evaluate, and create (McGatha et al., 2018).

Table 2.2

Codebook

Theme	Code	Definition	Example
Questioning	Initiation-response-feedback (IRF)	"[T]he teacher asks a question, a student responds, and the teacher provides or evaluates the response" (McGatha, Bay-Williams, Kobett, & Wray, 2018, p. 95)	"Which pencil is the shortest?" (Participant 2, Classroom Observation)
	Funneling	"[T]he teacher leads students through a series of questions to the teacher's desired end" (McGatha et al., 2018, p. 95)	"Do we have enough tens? How many tens? How many ones? Do I need to regroup?" (Participant 5, Classroom Observation)
	Focusing	"[T]he teacher asks questions based on the students' thinking to support them in thinking at high levels" (McGatha et al., 2018, p. 95)	"What strategy can we use to determine how many dots are under the splat?" (Participant 7, Classroom Observation)

Facilitation	"The only way for this proficiency to be developed is if teachers pose focusing question and facilitate discourse in ways that push students to describe their own solutions and evaluate or add to those shared by their peers" (McGatha et al., 2018, p. 101).	"How did you know?" (Participants 2, 3, 4, 5, & 7, Classroom Observations)

Questioning. The theme, **questioning**, refers to the different types of questions teachers used during mathematics instruction and includes the codes, *initiation-response feedback (IRF), funneling, and focusing questions.* The results revealed that all seven (100%) of the participants observed posed questions called *initiation-response-feedback (IRF)* (Table 2.3). *IRF* are questions teachers ask that require a very low level of cognitive demand (McGatha, Bay-Williams, Kobett, Wray, 2018). The student responds with an answer and the teachers assesses their answer with brief feedback (McGatha et al., 2018). For example, one teacher asked, "Which pencil is the shortest?" (Participant 2, Classroom Observation) and "Did he add or subtract?" (Participant 5, Classroom Observation). In this example, the response that teachers expected were brief such as yes/no or one one-word responses.

The findings also revealed that 14.29% (n = 1) of the participants observed used *funneling* to scaffold their students to the correct answer. In *funneling*, the teacher delivers a series of questions to lead students through the process of solving the problem (McGatha et al., 2018). In the following example, the process of questioning by the teacher illustrates funneling.

Teacher: We are going to subtract together. Do we have enough tens?

Teacher: How many tens?

Teacher: How many ones?

Teacher walks students through: 88-29? Do I need to regroup?

Teacher: What do I need to regroup? What do I need to break apart?

Teacher: Can I now take away 9 ones?

Teacher: Now I took away 9 ones, now what do I do?

(Participant 5, Classroom Observation)

This example illustrates the use of funneling to scaffold learning. The teacher begins with a broad question to elicit feedback from the students. If the students need more support, she then uses questioning to guide students through the step-by-step process of the mathematics problem.

Although a vast majority of the questions posed by teachers were IRF or funneling questions, nearly all the participants posed a focus question at least once during the observed mathematics lesson. Six (85.71%) of the participants observed used *focusing* questions to probe student thinking and deepen their understanding of the content. *Focusing* questions place more emphasis on student thinking to support the higher levels of cognitive demand (McGatha et al., 2018). Focusing questions are based on the students' work to support them to think at higher levels (McGatha et al., 2018). A *focusing* question was exemplified with, "What strategy can we use to determine how many dots are under the splat?" and "How do you know?" (Participant 7, Classroom Observation). In this example the teacher elicits a deeper level of student thinking to reach a higher level of cognitive demand by asking the students how they know their answer is correct.

Although 85.71% (n = 6) of the seven participating teachers used *focusing* questions throughout their lessons, the prevalence of these questions was low compared to *IRF* and *funneling* questions. Within the seven classroom observations in mathematics, 151 total questions were asked by the participating teachers. Of the 151 questions, 117 (77.48%) were *IRF* questions, 11 (7.29%) were *funneling* questions, and 23 (15.23%) were *focusing* questions. While all types of questions are necessary, *focusing* questions require a higher level of cognition, "probe into student thinking and ask them to make predictions, compare, classify, evaluate, analyze, or estimate" (McGatha et al., 2018, p. 95). An emphasis on preplanning *focusing* questions will promote a higher level of cognitive demand and expand student thinking in mathematics (McGatha, et al., 2018).

Table 2.3

Prevalence of Questioning

IRF	Funneling	Focusing
77.48%	7.29%	15.23%

All participants (n = 7, 100%) observed requested for students to share their answers through facilitation techniques. Furthermore, five (71.43%) of the participating teachers asked multiple students to share their answers to the same question given. Five (71.43%) of the seven participants were observed requesting students to share out the strategy they used to arrive at their answer. The participants asked the students questions such as "How did you know?" (Participants 2, 3, 4, 5, & 7, Classroom Observations). In addition, only one (14.29%) of the seven participating teachers asked multiple students to share their varying strategies to the same question given. None (0%) of the participants drew connections between the students' different strategies on how they calculated their answers. Drawing connections between strategies shows not only a high level of pedagogical content knowledge of the teacher, but also, the higher level of thinking of the student (McGatha et al., 2018). This facilitation technique encourages students to describe their problem-solving process and evaluate the processes shared by their peers, which involves analysis and evaluation—two of the highest levels in Bloom's Taxonomy (McGatha et al., 2018).

RQ2: How do first and second grade teacher's pedagogical content knowledge in mathematics influence student mathematics achievement?

To respond to the second research question, the teachers' responses to the MKT instrument and the students' mathematics assessment data were analyzed using descriptive statistics. From the data collected, descriptive trends and connections were revealed. The data showed a variance in mathematics pedagogical content knowledge. The scores ranged from five (17.85%) to 13 (44.8%) correct responses out of either 28 or 29 questions on the number concepts and operations portion of the MKT instrument, depending on the form assigned. Form A had a range of scores between five and ten (M=8.3, SD=2.4) and Form B had a range between nine and 13 (M=11.3, SD=1.5). On the geometry section of the MKT instrument, the scores ranged from eight (42.1%) to 13 (56.5%) correct responses out of either 19 or 23 questions, depending on the form assigned. Form A had a range of scores between eight and 12 (M=10, SD=1.6) and Form B had a range between eight and 13 (M=11.5, SD=2.1). The composite MKT scores range from 17 (33.3%) to 26 (50%) correct responses.

On the first grade Checkpoint Assessment 7, the mean score for students who receive free or reduced meal prices was an 87.19% (n=56) and 84.61% (n=56) for Checkpoint Assessment 8 (Table 3). Compared to the more affluent peers mean scores of 93.7% (n=32) and 89.92% (n=33), respectively. On the second grade Checkpoint Assessment 7, the mean score for students who receive free or reduced meal prices was 74.19% (n=36). Students who do not receive free or reduced meal prices scored a mean value of 81.34% (n=33). All participating teachers (n=7) had low MKT scores (Table 2.4). However, participant 2 had an MKT score of 26 (50%) and their students who received free or reduced meal prices had a mean standardized mathematics score of 96.44% on both Checkpoint 7 and 8, in comparison to those with a mean standardized mathematics score of 97.33% and 94.16%, who did not receive free or reduced meal prices. In addition, participant 7 had an MKT score of 17 (33.3%) and their students who received free or reduced meal prices have a mean standardized mathematics score of 72.86% in comparison to those with a mean standardized mathematics score of 82.38%, who did not receive free or reduced meal prices. Three out of the four teachers with the highest MKT scores had students with the highest standardized math score, however, this was not true for one teacher. Overall, the majority of students with a teacher whose MKT score was higher than average performed higher on standardized math assessments, but this trend is not the case for all students with a teacher who has high pedagogical content knowledge in mathematics. Furthermore, Participant 2 and 3’s students who receive free or reduced meal prices outperformed their more affluent peers on Checkpoint Assessment 8. There is one outlier worthy of noting. Although participant 4 does not fit this trend with a high MKT score of 23 (45.1%), a non-FARMs mean of 86.79% and a FARMs mean of 71.41%, she co-teaches a class in which other variables and may influence students' mathematics achievement. The data from the MKT instrument combined with the standardized mathematics data showed that teachers with low pedagogical content knowledge for teaching mathematics may influence students' mathematics achievement (Ball & Bass, 2000). Further, the mathematics achievement gap for teachers with lower MKT scores is more prevalent compared to the mathematics achievement gap for teachers with higher MKT scores.

Table 2.4

MKT Score and Checkpoint (CP) Mathematics Assessment Data

Participant	MKT Score	CP 7 Non-FARMs Mean	CP 7 FARMs Mean	Difference between Non-FARMs and FARMs	CP 8 Non-FARMs Mean	CP 8 FARMs Mean	Difference between Non-FARMs and FARMs
2	26	97.33%	96.44%	-0.89%	94.16%	96.44%	2.28%
3	24	96.67%	93.94%	-2.73%	96%	96.11%	0.11%
4	23	85.71%	75%	-10.71%	82.86%	67.82%	-15.04%
1	21	93.29%	85.92%	-7.37%	82.86%	81.02%	-1.84%
5	20	78.59%	66.92%	-11.67%			
6	17	83.5%	81.8%	-1.7%			

7	17	82.38%	72.86%	-9.52%

RQ3: What are teachers' levels of teaching efficacy?

To examine teaching efficacy, teachers' responses to the Teacher Efficacy Scale were analyzed using descriptive statistics. The Teacher Efficacy Scale is divided into two subscales: personal teaching efficacy and teaching efficacy. Personal teacher efficacy is the "belief that one has the skills and abilities to bring about student learning" and teaching efficacy is "belief that any teacher's ability to bring about change is significantly limited by factors external to the teacher" (Gibson & Dembo, 1984, p. 573).

Personal teaching efficacy. Six (85.71%) of the seven respondents moderately agree that their extra effort contributes to student performance. Three (42.86%) respondents agreed slightly more than disagree, three (42.86%) respondents moderately agreed, and one (14.29%) respondent strongly agreed, when a student masters a new concept quickly it is due to effective teaching practices. Finally, two (28.57%) of the participating teachers moderately disagreed that they can differentiate based on their students' needs.

Teaching efficacy. Four (57.14%) of the respondents moderately disagreed and one (14.29%) respondent strongly disagreed to the question that the hours spent in their classroom had little influence on student achievement compared to their home environment. Three (42.86%) respondents slightly agreed or moderately agreed that if students are not disciplined at home, they are unlikely to accept discipline at school. There is some variability in responses when rating the influences of the community compared to the influence of a teacher. Two (28.57%) respondents slightly disagreed that the influences of a student's home can be overcome by the effective teaching practices of an educator. Five (71.43%) of the seven respondents slightly agreed or moderately agreed that if parents would do more at home to support their children's learning, they could do more in school. Furthermore, two (28.57%) of the respondents slightly agreed or moderately agreed that even a good teacher may not reach many students

Teachers' perception of their capacity. With all factors considered, six (85.71%) of the seven respondents either moderately disagreed or strongly disagreed that teachers are not a very powerful influence on student achievement. Two (28.57%) of the seven respondents felt the school rules and policies hindered their ability to effectively do their job. However, even if they were given the opportunity to change their curriculum, one (14.29%) teacher strongly disagreed they had the necessary skills to successfully implement the new curriculum.

One (14.29%) respondent slightly disagreed that even with an adequate skill set, she could get through to her most difficult students. Two (28.57%) respondents slightly agreed or moderately agreed that if a student is off task, there is little they can do to increase their attention until that student is ready. Four (57.14%) of the seven respondents slightly disagreed or moderately disagree that they have enough training to deal with almost any learning problem.

RQ4: To what extent does teacher self-efficacy influence student achievement in mathematics?

To respond to the fourth research question, the teachers' responses to the Teacher Efficacy Scale were analyzed using descriptive statistics. From the data collected from the survey, the participants level of self-efficacy was unveiled (Table 2.5). Factor scores were calculated from the Teacher Efficacy Scale (Gibson & Dembo, 1984). Items from Factor 1 indicated a teacher's level of self-efficacy (Gibson & Dembo, 1984). There was a range of self-efficacy scores from 31 to 46 (range=15, n=7) and a mean value of 39.3 (M=39.3, SD=4.2). Items from Factor 2 indicated the level of teaching efficacy or outcome expectancy (Gibson & Dembo, 1984). There was a range of teaching efficacy scores from 18 to 27 (range=9) and a mean value of 23.1 (M=23.1, SD=3). A composite teacher efficacy score was computed by subtracting each participant's Factor 2 score from their Factor 1 score (Gibson & Dembo, 1984). The composite scores ranged from 11 to 22 (range=11, n=7) and had a mean value of 16.1 (M=16.1, SD=3.9). Teachers were labeled as having high or low self-efficacy with respect to the mean value of the sample (M=16.1, SD=3.9). If teachers had a composite score above the mean of 16, the teacher was labeled as having a high sense of efficacy. If teachers had a composite score below the mean value of 16, the teacher was labeled as having a low sense of self-efficacy. This composite score was used to analyze the effects of both teacher efficacy factors on student achievement in mathematics.

Table 2.5

Level of Self-efficacy, Outcome Expectancy, Composite Score, and Level of Efficacy

Participant	Level of Self-efficacy	Outcome Expectancy	Composite Score	Level of Efficacy
1	46	26	20	High

2	40	18	22	High
3	37	25	12	Low
4	41	22	19	High
5	41	27	14	Low
6	39	24	15	Low
7	31	20	11	Low

Participant 2 had a high composite score of 22, relative to the mean of the sample. Participant 2's students who received free or reduced meal prices have a mean standardized mathematics score of 96.44% on both Checkpoint 7 and 8, in comparison to those with a mean standardized mathematics score of 97.33% and 94.16%, who do not receive free or reduced meal prices (Table 2.6). Participant 2's students who receive free or reduced meal prices outperformed the students who do not receive free or reduced meal prices on Checkpoint Assessment 8 by 2.28 percentage points.

In comparison, participant 7 who had a low composite score of 11, their students who received free or reduced meal prices had a mean standardized mathematics score of 72.86% in comparison to those with a mean standardized mathematics score of 82.38%, who did not receive free or reduced meal prices. Participant 7's students who received free or reduced meal prices underperformed compared to their more affluent peers on Checkpoint Assessment #7 by 9.52 percentage points. Two out of the three participants with the highest Teacher Efficacy composite scores relative to the group, followed the trend.

For teachers with a higher teacher efficacy composite score, there was a small achievement gap between students who received free or reduced meal prices compared to those who did not. The majority of the time, the data from the Teacher Efficacy Scale combined with the standardized mathematics data showed a descriptive trend between a teacher's sense of self-efficacy and their students' mathematics achievement (Gibson & Dembo, 1984). Generally, as a teacher's level of self-efficacy increases, so does their students' performance on standardized mathematics assessments. Further, although there are some outliers, as a teacher's level of self-efficacy increases, the difference between non-FARMs' and FARMs' performance tends to decrease (Figure 2.1 and 2.2).

Table 2.6

Level of Efficacy and Checkpoint (CP) Mathematics Assessment Data

Participant	Level of Efficacy and Composite Score	CP 7 Non-FARMs Mean	CP 7 FARMs Mean	Difference between Non-FARMs and FARMs	CP 8 Non-FARMs Mean	CP 8 FARMs Mean	Difference between Non-FARMs and FARMs
2	High-22	97.33%	96.44%	-0.89%	94.16%	96.44%	2.28%
1	High-20	93.29%	85.29%	-7.37%	82.86%	81.02%	-1.84%

4	High-19	85.71%	75%	-10.71%	82.86%	67.82%	-15.04%
6	Low-15	83.5%	81.8%	-1.7%			
5	Low-14	78.59%	66.92%	-11.67%			
3	Low-12	96.67%	93.94%	-2.73%	96%	96.11%	0.11%
7	Low-11	82.38%	72.86%	-9.52%			

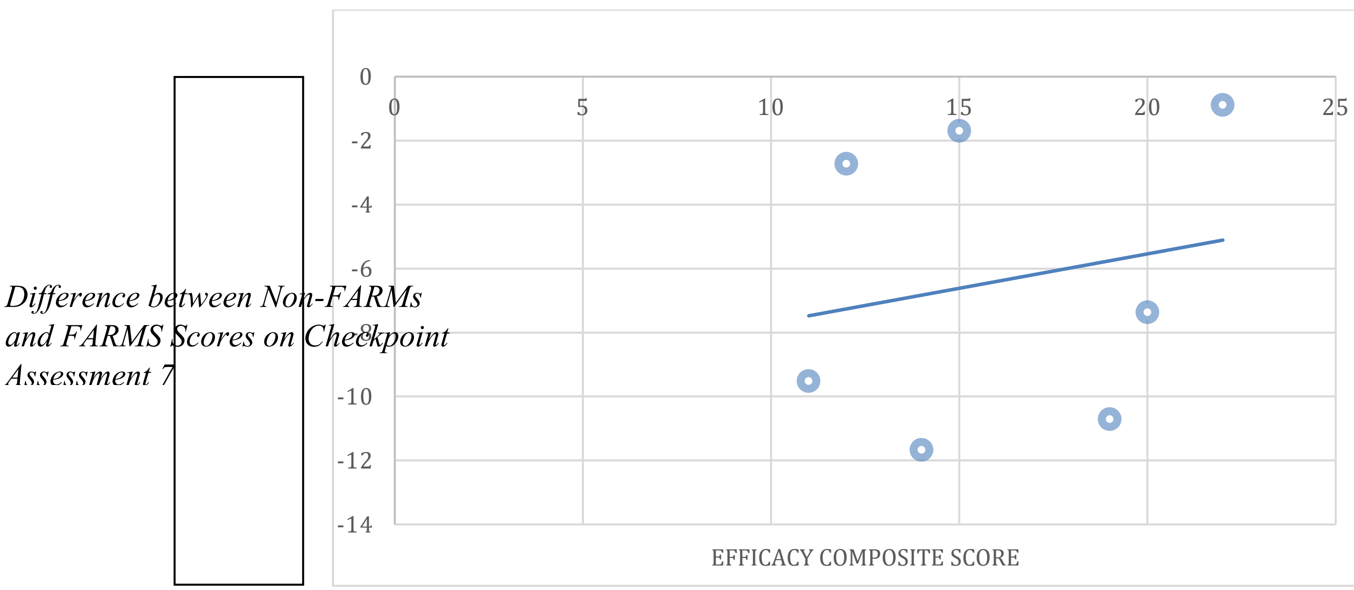

Figure 2.1. This figure demonstrates each teacher's efficacy composite score and the difference between non-FARMs' and FARMs' mean scores on Checkpoint Assessment 7.

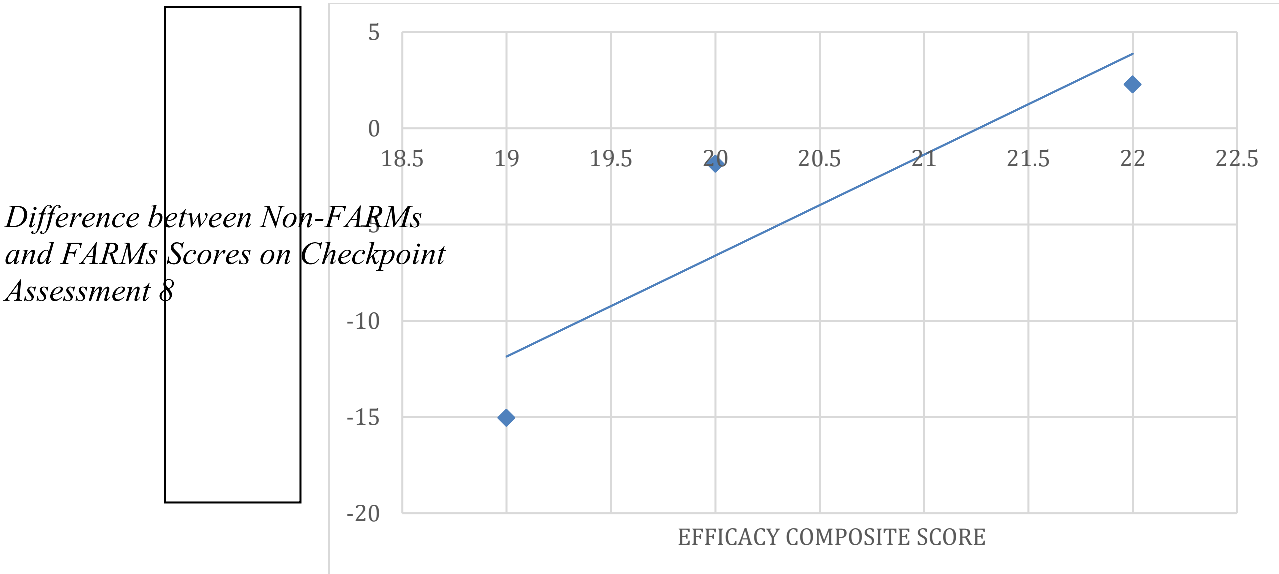

Figure 2.2. This figure demonstrates each teacher's efficacy composite score and the difference between non-FARMs' and FARMs' mean scores on Checkpoint Assessment 8.

Conclusion

The needs assessment presented the opportunity to analyze the factors contributing to the mathematics achievement gap between students who receive free and reduced meal prices compared to their more affluent peers. The participating classroom teachers' responses to the Teacher Efficacy Scale and the classroom observations conducted revealed varying ability levels in pedagogical content knowledge and self-efficacy. The vast majority (77.48%) of the questions posed by the participants during the mathematics observations were IRF questions, which require low cognitive demand from their students. The data from the MKT instrument and Teacher Efficacy Scale combined with the standardized mathematics data showed that a teacher's low pedagogical content knowledge and self-efficacy in teaching mathematics could influence their students' achievement on standardized mathematics assessments (Ball & Bass, 2000).

There are a few limitations to this needs assessment study. The findings from this study may not be generalized to other populations because of the sample size and it is based heavily on the participants' experience within this research study (Lochmiller & Lester, 2017). The purpose of this study is to improve the practice of the teachers participating and to consequently increase students' mathematics achievement.

The teachers' responses to the Teacher Efficacy Scale and the data collected from the classroom observations in mathematics demonstrate the need for supporting teachers' efficacy beliefs through the further development of their pedagogical content knowledge. Through the data collected during classroom observations, participants need further development in questioning techniques to increase their pedagogical content knowledge. Chapter 3 explores the literature for an intervention designed to best meet the professional development needs of the participating classroom teachers.

CHAPTER 3

Summary of Empirical Findings

The needs assessment presented the opportunity to further analyze the factors contributing to the achievement gap between students who receive free and reduced meal prices compared to their more affluent peers on standardized mathematics assessments. The participating classroom teachers' responses to the MKT instrument (Hill et al., 2004), Teacher Efficacy Scale (Gibson & Dembo, 1984), and the classroom observations unveiled varying levels of pedagogical content knowledge and a range of self-efficacy. Several key findings from the participants' responses and researcher's observations highlight important factors that must inform the design of the intervention. The purpose of this chapter is to provide an overview of the research related to interventions developed to support first- and second-grade teachers' pedagogical content knowledge and self-efficacy in teaching mathematics as identified by the needs assessment. Potential interventions are communities of practice, professional learning communities (PLCs), lesson studies, coaching, and mentoring. These interventions have the potential to influence the participants' pedagogical content knowledge and self-efficacy in teaching mathematics.

Rationale

As the needs assessment indicated, there are varying ability levels in teachers' pedagogical content knowledge and self-efficacy in teaching mathematics. However, three out of the four of the participating teachers with the highest MKT scores relative to the group, revealed a descriptive trend showing their students outperformed those with a teacher with a lower MKT score. Further, the mathematics achievement gap for teachers with lower MKT scores is more prevalent compared to the mathematics achievement gap for teachers with higher MKT scores. In addition to the influence of teachers' pedagogical content knowledge on students' mathematics achievement, as a teacher's level of self-efficacy increases, their students' performance on standardized mathematics assessments also increases. Furthermore, although there are a few outliers, as a teacher's level of self-efficacy increases, the difference between non-FARMs' and FARMs' performance on standardized mathematics assessments tends to decrease. The data from the needs assessment revealed a need for professional development to build teachers' pedagogical content knowledge and self-efficacy in teaching mathematics.

Theoretical Framework

Lave and Wenger argue that our learning is socially constructed through our own actions and by interacting with others (Lave & Wenger, 1991). Lave (1988) and Wenger (1998) discuss how learning is situated in the activities, context, and culture in which it occurs. Situated learning theory assumes that our understanding of a concept is continuously under construction and that knowledge needs to be presented in an authentic context (Orgill, 2007). In Lave and Wenger's (1991) research on adult learners, Lave observed the participants' mathematics skills within the classroom environment and compared these skills to those in the real world (Lave, 1988). Demonstrating the significance of making real world connections within the mathematics classroom, the participants revealed different competencies between the classroom and the real-world setting (Lave & Wenger, 1991). The understanding that learning is situated in the context of social interactions has been supported by Lave & Wenger

(1991) who connect these interactions to learning communities. Wenger (1998) posits that knowledge is developed within these learning communities and cannot be extricated from the context in which it occurs.

McLellan (1996) proposed a framework of instruction which aligns with situated learning theory and is based on the principles of coaching, opportunities for practice, collaboration, and reflection. McLellen (1996) suggests that each of these principles should occur within and authentic context to properly align with situated learning theory. In this model, coaching is when the facilitator provides scaffolding for learning and guides teachers to a place of understanding and competence. Further, teachers should be provided with numerous opportunities to practice and refine what they are learning in the professional development program. Professional development programs for teachers should foster collaboration for the social construction of knowledge. Finally, it is imperative for teachers to take time to reflect to improve their practice.

Synthesis of Intervention Literature

The Race to the Top (RTT) initiative was signed by President Obama as part of the American Recovery and Reinvestment Act (ARRA) of 2009. The law encouraged individual states to rally for funds from the $4.5 billion school improvement grant (SIG) to promote reforms that would result in considerable improvement in student achievement and to implement a stringent teacher evaluation system (Battersby & Verdi, 2015, p. 22). Each state was required to deliver beneficial professional development that included 'common planning and collaboration time for teachers (U.S. Department of Education, 2009, p. 10). SIG guidance documents stress job-embedded professional development that prioritizes "understanding what and how students are learning and on how to address students' learning needs, including reviewing student work and achievement data and collaboratively planning, testing, and adjusting instructional strategies, formative assessments, and materials based on such data" (U.S. Department of Education, 2011, p. 2). Every school has been required to put forth effort to incorporate common collaborative planning time to include all stakeholders on a regular basis (Battersby & Verdi, 2015).

In the United States, the most common form of professional development is one-time workshops which have virtually no impact on teachers and their students (Darling-Hammond et al., 2009; Yoon, Duncan, Lee, Scarloss, & Shapley, K., 2007). Annually, the majority of teachers receive fewer than 16 hours of professional development focused on specific mathematical content (Darling-Hammond, Hyler, & Gardner, 2017; Darling-Hammond et al., 2009). In contrast, research has shown 50 professional development hours or more is necessary to improve teacher quality (Yoon et al., 2007). Continuous professional development that puts content knowledge and pedagogical content knowledge in the forefront results in increased teacher competences and self-efficacy (Hord, 1997) and consequently, an increase in mathematics achievement (Desimone, Porter, Garet, Yoon, & Birman, 2002).

Communities of Practice

Incorporating time for teacher collaboration within the regular workday increases student outcomes and improves working conditions for teachers (Darling-Hammond, 2014). Wenger (1998) labels these groups of teachers who meet regularly and have a common goal as communities of practice. Communities of practice are voluntary and the members take the initiative to learn in a social context with colleagues who share similar values (Wenger, 2007). Research on communities of practice are based on "assumptions from sociological theoretical foundations on learning, which is itself a social theory for conceptualizing how learning happens from engaging in shared practices" (Lave & Wenger, 1991; Wenger, 1998). Teachers who participate in communities of practice are mutually engaged in activities such as planning effective instruction and creating challenging tasks (Wenger, 1998).

The effects of communities of practice on pedagogical content knowledge. Participating in communities of practice influences teachers' pedagogical content knowledge in mathematics (Gellert, 2013; Wenger, 1998). Within communities of practice, as teachers become more reflective, they begin to make more connections between mathematical concepts (Gellert, 2013). Furthermore, teachers express an increase in their self-confidence in mathematics content and teaching mathematics as a result of participating in a community of practice (Gellert, 2013). Communities of practice can influence teachers' pedagogical content knowledge in mathematics, specifically through questioning techniques (Yow & Lotter, 2014). This increase in pedagogical content has reportedly led to an increase in the teachers' self-efficacy in teaching mathematics (Yow & Lotter, 2014).

The effects of communities of practice on teachers' self-efficacy. A deeper understanding of content leads to a higher sense of self-efficacy, consequently increasing student achievement (Ball & Wilson, 1990; Darling-Hammond, 1996; Hill, Rowan, & Ball, 2005, Yow & Lotter, 2014). Participating in communities of practice influences the participants' confidence in content knowledge and pedagogy (Yow & Lotter, 2014). In the study conducted by Yow and Lotter (2014), techniques such as questioning and self-reflection, built confidence in the participants' practice. Strong knowledge in mathematical content and pedagogy increases teachers' sense of self-efficacy (Yow & Lotter, 2014). This new identity "can be seen through their knowledge of mathematics content and the confidence they experienced with mathematics teaching, learning, and understanding" (Yow & Lotter, 2014, p. 119).

Strengths and weaknesses. Participants' sense of self-efficacy and pedagogical content knowledge in mathematics can be influenced in the context of a community (Wenger, 1998). Furthermore, communities of practice have the potential to develop teachers' ability to effectively collaborate with colleagues, to become reflective practitioners, and to refine their practice (Yow & Lotter, 2014). These collaborative efforts can increase the participants' pedagogical content knowledge and self-efficacy in teaching mathematics (Roth, 2006). However, communities of practice have some limitations. Wenger, McDermott, and Snyder (2002) discuss the weaknesses of the possible intervention to include the groups' ability to trust others, to establish relationships and practice, and to cope with power issues. Furthermore, communities of practice are voluntary which can make it difficult to gain participants and sustain effort. Related to PLCs, which are discussed in the next section, communities of practice share a common goal and vision.

Professional Learning Communities

Teacher workgroups, grade-level teams, professional learning communities (PLCs), critical friends groups, and other collaborative approaches "dominate the teacher development landscape, it is clear that teacher-community-based strategies resonate with the practical needs and interests of school districts" (Bannister, 2018, p. 126). Although referenced by a variety of different names, the common vision of most community models is to encourage collaboration by teachers creating a professional culture (Bannister, 2018). Although there are similarities between communities of practice and PLCs, one striking difference is PLCs are started with a school's leadership team and are mandatory.

A successful PLC includes six key attributes. The first characteristic focuses on a supportive and shared leadership among PLC members (DuFour, 2004). Collaborative participation of the school's administration should share leadership, power, and authority through engaging staff members in the decision-making process (DuFour, 2004). Administrators are key to building an enabling school structure which teachers believe will help rather than hinder them in their work (Hoy and Sweetland, 2001). In consistently providing a time for teachers to work collaboratively in their PLCs, supportive administrators are sharing their leadership through cooperative decision making (Wu, Hoy, Hoy, & Tartar, 2012). The second key attribute expresses the importance of shared values and vision between members of the PLC (DuFour, 2004; Gee & Whaley, 2016). A shared vision involving all stakeholders pertaining to students' learning and is consistently used to guide the school's work (DuFour, 2004: Gee & Whaley, 2016). The third characteristic describes how collective learning and the application of learning among PLC members is necessary to develop effective solutions to meet the needs of the students (DuFour, 2004; Gee & Whaley, 2016). The fourth attribute of a PLC expresses the importance of sensitive and encouraging conditions (DuFour, 2004; Gee & Whaley, 2016). The environment and staff's ability should continually support the operation of a PLC through a collaborative and supportive atmosphere (DuFour, 2004; Gee & Whaley, 2016).

The fifth characteristic emphasizes shared practice (DuFour, 2004; Gee & Whaley, 2016). To actively support the improvement efforts of all members, observations should be conducted, and a review of each teacher's classroom behavior should be implemented to provide ample feedback (DuFour, 2004; Gee & Whaley, 2016). Finally, the last characteristic of an effective PLC accentuates the need for having a results orientation (DuFour, 2004). The informal data collected during daily instruction and standardized mathematics data should drive future instruction. A successful combination of these characteristics builds a solid foundation for an effective PLC.

PLCs offer an infrastructure to develop the supportive cultures and conditions necessary to accomplish momentous gains in instructional practices and student success (Morrissey, 2000; Dufour & Dufour, 2003). For collaborative cultures to be successful and communal, teachers need to participate in authentic interaction such as sharing mistakes and possess the ability to respectfully and constructively analyze and reflect on practices (Marzano, 2013). Louis and Kruse explain one of the primary characteristics of a successful individual in a PLC is willingness to accept feedback and work toward improvement (Louis & Kruse, 1995, p. 736). Effective PLCs can improve students' achievement in mathematics and increase teacher quality (Dufour & Mattos, 2013; Gee & Whaley, 2016).

The effects of professional learning communities on pedagogical content knowledge. Teachers should be equipped with specialized content knowledge of mathematics that prepares them to meet the challenges that occur when students are involved in learning the content and solving problems (Ball, Thames, Phelps, 2008). PLCs have been shown to be an effective strategy in improving mathematics achievement and increasing teacher quality (Gee & Whaley, 2016). In particular, continuous professional development that puts content knowledge and pedagogical content knowledge in the center results in increased teacher competences and in turn better student achievement (Desimone, Porter, Garet, Yoon, & Birman, 2002). Improved content knowledge equips teachers with a deeper understanding for meeting the instructional needs of their students (Gee & Whaley, 2016). Teachers who were interviewed by Gee and Whaley shared how "their own understanding of mathematical concepts on a deeper level assisted them when they were working with students [and how they] were better prepared to help students connect mathematics concepts for the construction of mathematical meaning" (Gee & Whaley, 2016, p. 95). In addition, the participants shared their change in practice focused on "student discourse, student thinking, and improved questioning strategies" (Gee & Whaley, 2016, p. 95). Thus, continuous professional development should address practical experiences, allowing teachers to try out their new competences in the classroom and to collect examples for further discussion. In mathematics PLCs, teachers who openly share their experiences benefit from the feedback from other teachers. Consequently, the cooperating teachers increase their pedagogical content knowledge by participating (Gee & Whaley, 2016).

Professional learning communities have been an intervention implemented to strengthen teachers' mathematical content knowledge and pedagogy. PLCs focused on instructional strategies for upcoming content standards can influence teachers' implementation in the classroom (Desimone et al., 2002). Desimone and colleagues (2002) conducted a study using a purposefully selected sample of 207 teachers in 30 schools, in ten districts across five states to measure teacher change in practice from 1996 to 1999. The teachers participated in a survey to discover key features of professional development which the participants' perceived a change in their knowledge of skills, content, and practice. The researchers found that professional development focused on specific instructional practices increased teachers' use of those practices in the classroom. Furthermore, specific strategies, such as active learning opportunities, increased the influence of the professional development on teacher's instruction (Desimone et al., 2002).

The effects of professional learning communities on teachers' self-efficacy. PLCs contribute to the amount of exposure the participating teachers have in gaining mastery experience. This high level of experience positively influences teachers' level of self-efficacy (Weißenrieder, Roesken-Winter, Schueler, Binner, & Blömeke, 2015). Hord's (1997) work revealed working in a PLC had a strong effect on teachers' instructional practices, especially on self-efficacy and implementing highly effective lessons. Teachers with a higher level of self-efficacy tend to choose more challenging tasks for their students (Bandura, 1997), support them more frequently, and have more patience with students with special needs (Schwarzer & Jerusalem, 2002).

PLCs have the ability to influence teachers' (a) content knowledge, (b) ability to meet diverse learning needs, and (c) confidence in closing the achievement gap (Caskey & Carpenter, 2012). In a study conducted by Mundschenk and Fuchs (2016), 84 teachers participated in a PLC over the course of a year. During the PLC sessions, the participants engaged in data-based decision making which included monitoring student progress, implementing evidence-based interventions, and documenting procedural fidelity. At the end of the intervention, the teachers participated in a survey to measure the value of the PLC sessions on a 5-point Likert scale. The survey specifically asked teachers about the degree of helpfulness (from 'not at all' to ‘extremely’) of the intervention. The data collected by the survey revealed teachers who valued data driven decision-making and saw progress in their students’ work, had a higher level of self-efficacy and stressed less about what students were unable to do and more about what was in their sphere of control; specifically pedagogical content knowledge.

Strengths. PLCs have the “potential to make space for collective engagement to improve instruction and learning” (Bannister, 2018, p. 134). In the last few decades, there has been a shift from teachers working in isolation, to teachers working in collaboration (Krainer, 2003), bringing a social dimension to teacher professionalization (Weibenrieder, Roesken-Winter, Schueler, Binner, & Blomeke, 2015, p. 29). Most teachers need guidance and a clear understanding of specific strategies they can follow within a supportive structure where previously isolation has been the norm (Gee & Whaley, 2016).

Gee and Whaley (2016) found teachers valued the importance of collaboration with peers that emphasized student response to lessons as beneficial to their professional development. The participating teachers discussed the importance of having enough time to collaborate with colleagues to improve problem-based lessons and teaching practices (Gee & Whaley, 2016). Specifically, all teachers interviewed demonstrated a change in practice which involved a deeper understanding of the importance of using problem-based instruction to strengthen students’ conceptual understanding of mathematics (Gee & Whaley, 2016). Participating in reflection exercises with peers, motivates teachers to question and alter the way they teach mathematics (Gee & Whaley, 2016).

Weaknesses. Strict policies with high accountability measures have unintended consequences. A high amount of pressure is placed on mathematics teachers to work collaboratively which can increase the likelihood of contrived participating in PLCs (Hargreaves, 1994; Grossman, Wineburg, & Woolworth, 2001). Making matters worse "current [school] structures…rarely allow for deep engagement in joint efforts to improve instruction and learning" (Wei, Darling-Hammond, & Adamson, 2010, p. vi), which avoids the critical collaboration necessary for increasing teacher knowledge (Bannister, 2018). These misconceptions have persuaded large masses of schools and districts to implement well-intended yet underdeveloped PLC reforms based on the relationship between teachers' participation in PLCs and an increase in student success (Bannister, 2018).

The Common Core States Standards initiative which aims to support students' development of critical thinking and problem-solving abilities places additional demands on teachers. Teachers confess they are unprepared to implement these changes (EPE Research Center, 2013). One persistent challenge they encounter is time. In the United States, teachers spend about 80% of their workdays on teaching, while their counterparts in other, high-performing nations spend about 60% and have the remainder available for collaboration and professional learning (OECD, 2014). Teachers are rarely given "adequate time, support, compensation, and collective autonomy when going about this work on the job" (Bannister, 2018, p. 134). One-time professional development workshops position teachers as receivers of information (Darling-Hammond et al., 2009). Consequently, the traditional approach to professional development replicates challenges with traditional approaches to teaching and learning (Taton, 2015). Teachers “inevitably become passive, disengaged, and struggle to apply what is being taught to their classrooms” (Taton, 2015, p. 4).

Although the research conducted on PLCs gives definitions, descriptions, and examples of what schools they should look like, the documentation of the professional development for teachers within a PLC often lacks details about the ongoing processes (Gee & Whaley, 2016). Smylie discussed how, “…it is not clear how much communities have come to be or how they may be created and sustained through programs and policies” (Smylie, 1994, p. 165). In addition, Hipp, Huffman, Pankake, and Olivier (2008) postulated that PLC structures that work effectively in one school, might not successfully transfer to another school, yet another barrier for administrators and teachers who are searching for methods to encourage continuous improvement for student achievement in mathematics.

PLCs require data driven action that is focused on creating a culture of learning for teachers and students, but strategies for structuring and supporting this continuous professional development is lacking in the research (DuFour & DuFour, 2003). Administrators and teachers need an infrastructure to guide the processes of these communities to positively impact student achievement in mathematics (DuFour & Eaker, 1998). Most teachers need specific steps and strategies they can follow within the time set aside for their PLC (Gee & Whaley, 2016).

The idea of collaboration in PLC to increase student achievement is a recent development in the United States (DuFour, DuFour, & Eaker, 2008). For administrators and teachers, the change can be challenging to manage effectively (DuFour et al., 2008). While teachers and researchers (Hipp, et.al, 2008) in the United States have recently searched for guidance and supports for PLCs, collaboration with colleagues has been a common practice in other countries (Hamos, Bergin, Maki, Perez, Prival, Rainey, & VanderPutten, 2009; Wong, Britton & Ganser, 2005). Using a lesson study model within a mathematics PLC will emphasize student learning and increase student achievement (Chokshi & Fernandez, 2005).

Lesson Study

Fernandez (2005) discusses how lesson studies can provide teachers with opportunities to learn how to plan effective mathematics instruction. In the lesson study model, there is a direct set of guidelines about how teachers learn (Gee & Whaley, 2016). Including the process of a lesson study sequence to a PLC provides a system for effectively addressing student achievement in mathematics (Gee & Whaley, 2016). The five attributes Hord (1997) suggests for incorporating a lesson study into a PLC included: (a) supportive and shared leadership, (b) shared values and vision, (c) collective learning and application of learning (d) supportive learning environment, and (e) shared practice. Lesson studies influence teachers' consciousness of student learning through observations and self-reflections (Gee & Whaley, 2016).

The effects of lesson studies on pedagogical content knowledge. Lesson studies provide participants with an opportunity to collaborate to further develop their conceptual understanding of mathematics and to improve their practice. Gee and Whaley (2016) conducted a study with 16 teachers who instructed grades three through five in mathematics.

Participants were selected based on their limited course work in mathematics while they were in college. The teachers met four times during the fall semesters over the course of two years.

The lesson study process began with selecting a research lesson to implement, observe, analyze, reflect, and refine. The lesson study sequence continues by discussing the students' unique needs and the focus for improvement during the lesson observation. The next step in the lesson study process involves the lesson observers taking notes while the participant who is teaching the research lesson goes through implementation with their students. After the participants reflect and discuss student learning, the team brainstorms ideas on how to improve the lesson for future iterations. In a cyclical fashion, the lesson study sequence with the improved research lesson is applied every time a member of the lesson study group implements the lesson with their class (Gee & Whaley, 2016).

In addition to the observations and discussions, the teachers participated in semi-structured interventions and a self-reflection journal (Gee & Whaley, 2016). The qualitative coding process revealed lesson studies had an influence on teachers' practice of teaching mathematics. The teachers expressed that they learned how to effectively plan and implement lessons to meet their students' needs which increased their pedagogical content knowledge in mathematics. The results from the reflection journal concluded, teachers felt the lesson study forced participants to collaborate, and discuss ideas for improving their practice with colleagues. Furthermore, the results showed the lesson studies provided teachers with a deeper understanding of problem-based instruction to further develop students' conceptual understanding of mathematics. When teachers were interviewed, they described feeling better prepared to help students to develop a deeper sense of mathematical meaning. The participants sense of "mathematics content knowledge was strengthened, and their understanding of mathematical relationships and connections were deepened which led to positively impacting their teaching of mathematics to children" (p. 95). Furthermore, the teachers described a change in their students' discourse and thinking. The teachers' pedagogical content knowledge was further refined using higher-level questioning and asking their students to explain their thinking. These techniques were developed through the participation in the lesson study process (Gee & Whaley, 2016).

The effects of lesson studies on teachers' self-efficacy. Teachers' sense of self-efficacy is increased when teachers connect certain teaching behaviors with success, whereas teachers' connection to failure can have the opposite effect (Tschannen-Moran & Woolfolk Hoy, 2007). In an explorative study conducted by Schipper, de Vries, Goei, & van Veen (2020), 61 teachers from eight secondary schools located in the Netherlands participated in at least two lesson study sequences over the period of one academic year. The teachers participated in the Teachers' Sense Self-Efficacy Scale which contained 24 items with a nine-point Likert scale to measure their sense of self-efficacy (Tschannen-Moran & Woolfolk Hoy, 2001). One significant subscale ('efficacy in student engagement') was found between both groups over time in favor of the intervention group ($F(1.00, 58.00) = 8.64$, $p < .01$). Within-group analyses showed that all three subscales in the intervention group significantly increased in 'efficacy in student engagement' ($t(36) = -2.79$, $p < .01$), 'efficacy in instructional strategies' ($t(36) = -3.64$, $p < .01$), and 'efficacy in classroom management' ($t(36) = -2.57$, $p < .05$). Additionally, there were no significant differences found in the comparison group (Tschannen-Moran & Woolfolk Hoy, 2001). The data revealed that the subscale 'efficacy in student engagement' significantly differed between both groups over time, in favor of the group of teachers who participated in the lesson study. Furthermore, all three subscales of the Teachers' Sense Self-Efficacy Scale showed a significant increase in the lesson study group compared to the control group (Schipper et al., 2020). There appears to be a relationship between teacher self-efficacy and participation in the lesson study process (Puchner and Taylor 2006; Schipper et al., 2020; Sibbald, 2009).

Strengths and weaknesses. Opportunities for collaboration including peer observations and feedback produce an increase in teachers' sense of self-efficacy (Tschannen-Moran and Woolfolk Hoy, 2007). After conducting a literature review on lesson studies as a possible intervention, the research shows lesson studies have the ability to increase teachers' inquiry stance, attitudes, and self-efficacy beliefs (Puchner & Taylor, 2006; Sibbald, 2009; Schipper et al, 2018), in addition to pedagogical content knowledge in mathematics (Schipper et al., 2018).

Although there are numerous benefits for participation in lesson studies, there are two challenges to overcome. Lesson studies require teachers to teach the same research lesson through numerous iterations, while the team of teachers observes and offers valuable feedback (Gee & Whaley, 2016; Tschannen-Moran & Woolfolk Hoy, 2007). This process will require an extensive amount of time dedicated to one research lesson with a flexible mathematics curriculum. The curriculum will have to allow multiple educators in a grade level to teach the same research lesson at different times. There will also be a need for substitute teachers for each of the participants' classrooms for every iteration because this team of classroom teachers will be observing the teacher implementing the research lesson. This could be a challenge for schools who have a difficult time acquiring substitute teachers. Lesson studies have the ability to influence teachers' pedagogical content knowledge and self-efficacy (Gee & Whaley, 2016; Schipper et al., 2018; Tschannen-Moran & Woolfolk Hoy, 2007), however the intervention may not be logistically feasible.

Coaching

A coaching cycle is an intervention where the mathematics coach works alongside the teacher to improve teaching practice in the classroom (Yopp, Burroughs, Sutton, & Greenwood, 2017). Coaching is a professional development tool for teachers that can influence student achievement (Yopp et al., 2017). There are numerous variations of coaching cycles, these include: cognitive coaching, instructional coaching, content-focused coaching, and mathematics coaching. In cognitive coaching, the coach uses reflective questions to guide participants into further developing their knowledge bases (Costa & Garmston, 2002). Instructional coaching allows the coach to co-plan lessons with the classroom teacher to assist them in drawing connections among mathematical concepts (Knight, 2007). For participants who may need a more explicit approach in learning content knowledge, a coach may choose a content-focused coaching method (West & Staub, 2003). In mathematics coaching, coaches teach content knowledge in addition to effective instructional practices (Hull, Balka, & Miles, 2009). Content-focused and mathematics coaching require the coach to have a higher level of content knowledge and experience than the participant (Hull et al., 2009; West & Staub, 2003), whereas instruction and cognitive coaching do not (Costa & Garmston, 2002; Knight, 2007).

As a possible intervention, coaching should support teachers in various ways based on the individual needs of the participants. Coaches should work to improve areas of weakness that the teacher suggests in addition to areas of weakness the coach observes (West & Staub, 2003). Coaches should support teachers in developing their own content knowledge in mathematics and understanding their students' mathematics content knowledge (Sutton, Burroughs, & Yopp, 2011). It is the coach's role to share the most updated research on instructional practices and data analysis to drive coaching conversations (Hull et al. 2009). Coaches should use reflective questions with teachers as a tool in coaching sessions (Costa & Garmston, 2002). Finally, and most importantly, a coach must be a motivator for change while balancing a professional and trusting relationship with teachers (Yopp et al., 2017).

The effects of coaching cycles on pedagogical content knowledge. Research supports coaching can be an effective mode of professional development to influence teacher practice (Biancarosa & Bryk, 2011; Powell & Diamond, 2011; Neuman & Wright, 2010) and student achievement (Campbell & Malkus, 2011; Biancarosa & Bryk, 2011; Powell & Diamond, 2011).

Mathematics coaches should have a deep understanding of content knowledge taught by the participants (Yopp et al., 2017). This level of content knowledge will be imperative when a classroom teacher needs support in further developing their mathematical content knowledge (Yopp et al., 2017). A study conducted by Yopp, Burroughs, Sutton, and Greenwood (2017) implemented coaching cycles to improve teachers' pedagogical content knowledge and self-efficacy in teaching mathematics. Yopp and colleagues (2017) included 180 kindergarten through eighth grade teachers across eight states. The study took place over the course of two years including a summer institute. The results of the MKT instrument showed an increase in teachers' mathematics knowledge, mathematics teaching practices, and self-efficacy. When implemented with fidelity, coaching can provide the teacher with guidance on how to engage with mathematics content and pedagogical content knowledge (Desimone & Pak, 2017). When teachers are provided the opportunity to co-plan lessons with a coach that meet the needs of their students, there is an impact on student understanding (Desimone & Pak, 2017).

The effects of coaching cycles on teachers' self-efficacy. Coaching cycles can have an influence on teachers' level of self-efficacy in teaching mathematics. A qualitative study was conducted by Bruce and Ross (2008) to determine if teachers' level of confidence had an impact on student achievement for students who were in grades three and six. In the sample, there were eight third grade and four sixth grade teachers who participated in the four face-to-face coaching sessions focused on getting teachers acquainted with coaching, pedagogical content knowledge, and reform-based mathematics. All twelve participants were observed before and after the implementation of the coaching sessions. Five observers recorded observations of: "(a) selection of mathematical tasks, (b) student construction of mathematical knowledge, and (c) support for student-student interaction" (Bruce & Ross, 2008, p. 354). Bruce and Ross (2008) developed a formal observation protocol based on the research literature, a wide array of classroom observations, NCTM policy statements, and classroom teacher interviews. From the data collected using the observation protocol, the researchers discovered that participants who were more willing to implement a constructivist approach to mathematics instruction, were more likely to offer open-ended mathematical tasks to students. Furthermore, the researchers determined that participating in coaching cycles provided teachers with the opportunity to become reflective practitioners about their instructional practices. During the pre and post intervention interviews, the instructional coaching method used in this study increased teacher sense of self-efficacy in teaching mathematics as a result of the partnership built between the coach and the teacher (Bruce & Ross, 2008).

Strengths and weaknesses. Coaching cycles have many benefits for participants, as well as their students. However, there are some limitations for this possible intervention. It is a challenge to build a trusting relationship between a coach and the teacher being coached while being a facilitator for change (Yopp et al., 2017). A possible strength of coaching cycles is the opportunity for building a positive, professional relationship between the coach and the teacher centered around content, pedagogical content knowledge, and student learning (West & Staub, 2003). However, the relationship must allow the coach to have difficult conversations with teacher to improve their practice (Knight, 2007). Focusing coaching conversations on student learning by using student work samples is a way to prompt teacher self-reflection as opposed to passing judgement from the coach to the participating teacher about their teaching practices (Yopp et al., 2017).

As an additional hurdle, coaches are to inform and stay connected with the school's administration to align their work with the school improvement plan (Knight, 2007; West & Staub, 2003). Coaches should update the principal about the participants' progress toward meeting the mathematics goal in the school improvement plan (West & Staub, 2003). This role of the coach has the potential to create tension between the coach and the teacher because of their positionality within the school's community (Hull et al., 2009). To alleviate this tension, coaches should begin by building a trusting relationship with teachers to prevent the coach from developing a reputation of reporting to principal as their sole purpose (Hull et al., 2009).

Online PLCs and Coaching

With an increase in available technology, the traditional face-to-face professional development has transformed into a web-based environment (Tsai, 2015). Some research studies have shown that online PLCs play a key role in teachers' learning and professional development (Kao, Tsai, & Shih, 2014; Prestridge, 2010). Online PLCs provide the opportunity for teachers to participate in flexible professional development (Zhang, Liu, & Wang, 2016). An online teacher training program can expand learning opportunities, provide a time for self-reflection, feedback from peers, and construction of learning communities (Kao et al., 2014). The use of an online PLC can support teachers' pedagogical content knowledge through sharing resources, developing strategies, and interacting with peers (Holmes, 2013).

Like online PLCs, online coaching involves getting feedback and support from peers for the purpose of improving their instructional skills and techniques (Zhang et al., 2016). Finally, peer coaching among teachers who participate in online PLCs provides not only emotional support, but an opportunity for reflective practices to improve performance (McAllister & Neubert, 1995). This improvement in performance from participating in not only online coaching, but also online PLCs has the capability to increase teachers' sense of self-efficacy in teaching mathematics (Nurlu, 2015). Furthermore, teachers' self-efficacy has a positive relationship with student achievement in mathematics (Althauser, 2015).

Mentoring

In the past, the main role of mentors was to provide social and emotional support for new teachers to address high attrition rates (Feiman-Nemser, Schwille, Carver, & Yusko, 1999). As a result of common core standards and high accountability measures, teachers and policy-makers have implemented mentoring programs to build teachers' content knowledge (Achinstein & Davis, 2014). Mentors with a content focus should reinforce pedagogical content knowledge and analyze student work (Luft, Neakrase, Adams, Firestone, & Bang, 2010).

Mentors should be aware of their novice teachers' needs, readiness, and strengths (Achinstein & Davis, 2014). While novice teachers need the social and emotional support provided by mentors, they also need content-specific mentors to further develop pedagogical practices (Achinstein & Davis, 2014).

The effects of mentoring on pedagogical content knowledge. New teachers equipped with in-depth content knowledge, still need to develop their pedagogical content knowledge (Achinstein & Davis, 2014). Pairing novice teachers with mentors who have taught the same content is associated with positive outcomes for the novice teacher and their students (Boyd, Grossman, Hammerness, Lankford, Loeb, Ronfeldt, & Wyckoff, 2012). Mentoring can have a positive influence on teachers' understanding of the nature of their subject, inquiry-oriented lessons, student-centered instruction, and reformed-based practices (Wang, Strong, & Odell, 2004). The influence mentoring can have on teachers' pedagogical content knowledge has shown positive effects on students' mathematics achievement (Achinstein & Davis, 2014). Mentoring focuses on building teachers' capacity to support their students' understanding of the mathematics content (Achinstein & Davis, 2014).

Strengths and weaknesses. Mentoring has shown to have a positive influence on novice teachers' understanding of content knowledge and student learning (Boyd et al., 2012). Mentoring program not only have the ability to minimize teacher attrition by supporting novices' social and emotional needs, but mentoring programs can also have a dual focus of building teachers' pedagogical content knowledge (Achinstein & Davis, 2014). Although there are many benefits to mentoring programs focused on pedagogical content knowledge, there are some challenges. First, mentors split their attention between the students and novice teacher in relation to content knowledge (Wang et al., 2004). Additionally, mentors must be well-versed in pedagogical content knowledge that leads to student learning, while meeting the needs of their novice teachers (Wang et al., 2004). Finally, mentors must be skilled in assessing students, aligning the curriculum with the content standards, and formatively assessing their novice teachers (Athanases & Achinstein, 2003).

Overview of Proposed Intervention

Researchers have determined that teachers who have a deeper understanding of the content and are confident in their ability to deliver instruction to students are more likely to positively impact student achievement (Bruce & Ross, 2008; Hartman, 2013). The needs assessment revealed students of a teacher with a higher level of pedagogical content knowledge and a higher sense of self-efficacy tend to outperform students of a teacher with a lower level of pedagogical content knowledge and a lower sense of self-efficacy. For first- and second-grade teachers, the impact of participating in a mathematics PLC and coaching cycles over the course of several months has the potential to support teachers' pedagogical content knowledge and self-efficacy to influence the problem of practice in the future.

The intervention for this study included first- and second-grade classroom teachers in mathematics PLC meetings and coaching sessions over the course of four months. Four, 60-minute PLC meetings will be implemented to discuss upcoming content standards, strategies for effectively teaching the mathematical content, analyze student work, and collaborate to make data driven decisions for future instruction. In addition to participating in a mathematics PLC, the teachers will participate in three monthly coaching sessions. The coaching methods will be based on the needs of the participant sample and the coach will be present for a pre-conference, lesson implementation, and a post-conference. The teachers will participate in a pre- and posttest survey to measure their level of pedagogical content knowledge and self-efficacy in teaching mathematics. In addition to the surveys, the teachers also participate in a focus group to provide the researcher with an in-depth understanding of the quantitative outcomes and their overall experience (Desimone & Pak, 2017).

Conclusion

While there are many complex factors contributing to an achievement gap between students who receive free or reduced meal prices compared to their more affluent peers on standardized mathematics assessments, teachers' pedagogical content knowledge and self-efficacy are key. The literature review of possible interventions has determined participating in mathematics PLCs and coaching cycles can influence teachers' pedagogical content knowledge and self-efficacy (Bruce & Ross, 2008; Gee & Whaley, 2016). Additionally, research reveals participation in PLCs and coaching are effective in increasing students' achievement in mathematics (Chokshi & Fernandez, 2005). With the overwhelming demands weighing on classroom teachers' shoulders, they deserve a safe learning environment to reach their full potential and to best meet their students' needs.

CHAPTER 4

Intervention Procedure and Program Evaluation Methodology

The needs assessment conducted at ABC Elementary School revealed a need to increase teachers' pedagogical content knowledge and self-efficacy in teaching mathematics. The literature review provided possible interventions to supply the teachers in the target population with the appropriate professional development. The options included communities of practice, PLCs, lesson studies, coaching, and mentoring. Lesson studies are not feasible because of time restrictions, lack of curricular flexibility, and available resources. This setting already has a mentoring program in place that supports teachers' emotional and content knowledge needs. A combination of mathematics PLCs and coaching will be most feasible and effective in meeting the needs of the participating teachers and their students. The mathematics PLC and coaching program, detailed in the logic model (Figure 4.1), aimed to engage the first- and second-grade teachers in four online PLC sessions and 12 online coaching sessions (Appendix D), however, only two second grade teachers participated. The intervention incorporated professional development on the upcoming mathematics standards, strategies, and questioning techniques to support teachers' professional learning.

The research study described in this chapter is situated within research literature on building teachers' pedagogical content knowledge and self-efficacy to improve students' mathematics achievement. Increasing the mathematics achievement of students who receive free or reduced meal prices on standardized mathematics assessments through mathematics PLCs and coaching sessions for teachers required an investment of resources and activities. The intervention included two second-grade classroom teachers, the Title I Mathematics Teacher, and support from administration. The intervention included a combination of mathematics PLCs and coaching sessions which occurred from January through April of 2021. The mathematics PLCs were implemented once a month for a 60-minute time frame, totaling four hours. Each classroom teacher participated in three 30-minute coaching sessions per month, totaling six hours. The PLCs and coaching sessions provided a total of ten hours of continuous professional development over the course of four months. The session topics were centered around building teachers' pedagogical content knowledge for upcoming mathematics standards and strengthening the teachers' questioning to include more *focusing* questions. *Focusing* questions emphasize student thinking to support higher levels of cognitive demand (MGatha, Bay-Williams, Kobett, & Wray, 2018). The attention directed towards teachers' questioning is a connection to the data collected in the needs assessment. The data collected from the classroom observations revealed only 23 out of 151 questions posed by teachers (15.23%) were *focusing* questions. In addition, the participants had access to all the mathematics resources, including manipulatives, and to the Title I Mathematics Teacher.

There were three desired outcomes of the intervention. With the implementation of PLCs and mathematics coaching, the short-term outcome of this intervention was to increase teachers' pedagogical content knowledge (DuFour, 2004; Gee & Whaley, 2016). By increasing teachers' pedagogical content knowledge, the intermediate goal was to increase teachers' self-efficacy as a result of building solid pedagogy and content knowledge in mathematics (Gibbons & Cobb, 2016; Yopp et al., 2017). Beyond the possible scope of this study, a long-term goal would be to influence student achievement on standardized mathematics assessments (DuFour

& DuFour, 2003) and to close the achievement gap between students who receive free or reduced meal prices compared to their more affluent peers.

The researcher is making some assumptions about the target audience for this study. First, the researcher assumes the first- and second-grade teachers at ABC Elementary School hope to increase student outcomes on standardized mathematics assessments. Second, the researcher assumes teachers want to engage in study participation. Finally, the researcher is assuming the participants will accurately report reflections of their self-efficacy in teaching mathematics. External factors that may influence this research study are: administration attrition, factors influencing student achievement on standardized mathematics assessments, and the teacher workload of being employed by a challenging Title I school with a new reading curriculum, where mathematics is not the school focus. This chapter specifies the procedures for not only the intervention, but also the program evaluation. The chapter outlines the purpose of the study, guiding research questions, research design, study procedures, data collection methods, and the appropriate analyses.

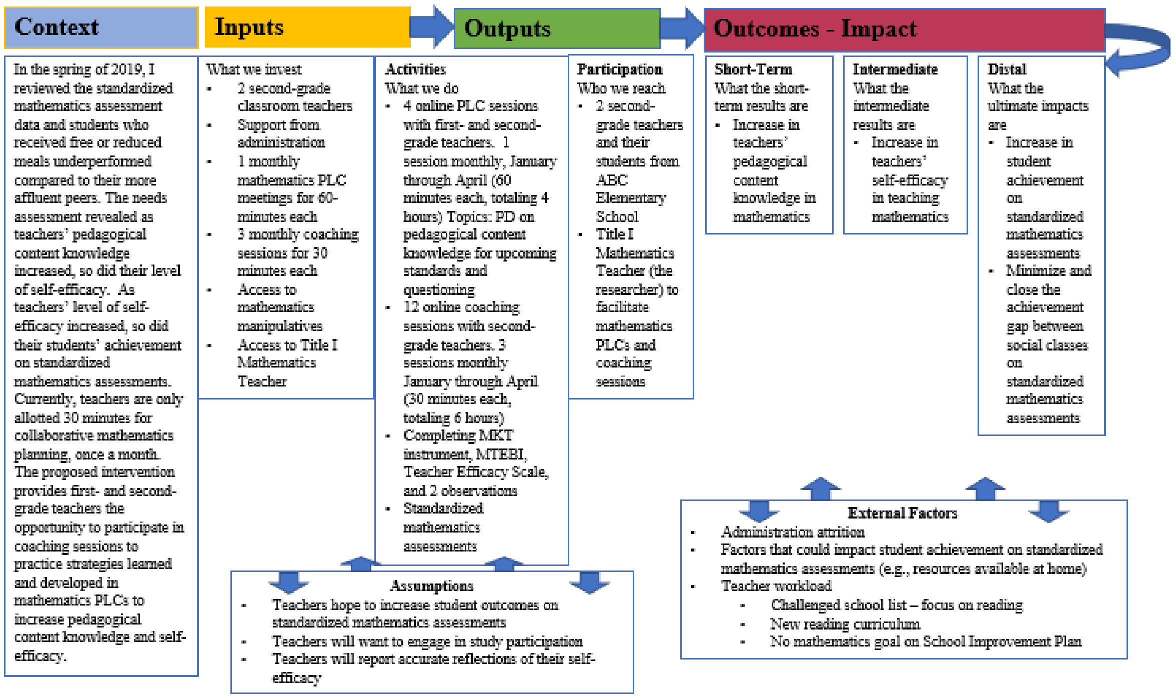

Figure 4.1. Logic model for the mathematics PLCs and coaching program

There is a distinction between the intervention components with respect to what is required as part of the researcher's responsibilities and the research study. In particular, the professional learning community sessions is a requirement for all teachers to participate in. While participation in the professional learning community is required, participation in the data collection aspect of the research study is not required. Additionally, the coaching aspect of the intervention study was voluntary for the classroom teachers.

Purpose of the Study

The purpose of this research study is to examine how participating in the program changes teachers' mathematics pedagogical content knowledge and self-efficacy in teaching mathematics. The intervention included a combination of mathematics PLCs and coaching. The hypothesis was that by participating in the intervention, teachers will experience an increase in pedagogical content knowledge and report an increase in their sense of self-efficacy in teaching mathematics.

Research Questions

The research study explored five research questions. The process evaluation questions focused on project fidelity, contextual support, and participant responsiveness. Further, the outcome questions focused on the influence of the intervention on teachers' pedagogical content knowledge and self-efficacy. The research questions were as follows:

Process Evaluation

RQ1: In what ways did the intervention adhere to the proposed timeline, number of sessions, content, and activities of the mathematics PLCs and coaching cycles?

RQ2: How did teachers describe the administration's support of the intervention?

RQ3: What was the level and quality of participant engagement in the mathematics PLCs and coaching cycles?

Outcomes Evaluation

RQ4: How did participating in mathematics PLCs and coaching cycles change teachers' pedagogical content knowledge?

RQ5: How did teachers' sense of self-efficacy change after participating in mathematics PLCs and coaching sessions?

a. How did teachers' mathematics teaching efficacy beliefs change after participating in mathematics PLCs and coaching sessions?

Research Design

The role of the mixed methods paradigm opened opportunities for the researcher to use a variety of quantitative and qualitative data collection methods and analyses to effectively satisfy the objective of the process and outcome evaluation. The evaluation design allowed the researcher to merge and connect various methods to best meet the evaluation objectives and answer the research questions (Creswell & Plano-Clark, 2018). First, the researcher collected quantitative pre-test data using the MKT instrument (Hill et al., 2004), the Teacher Efficacy Scale (Gibson & Dembo, 1984), and the Math Teaching Efficacy Beliefs Instrument (MTEBI) (Althauser, 2015) to measure the teachers' level of pedagogical content knowledge and self-efficacy in teaching mathematics (Appendices A, B, and E, respectively). During the process evaluation process, the teachers completed exit ticket surveys (Appendix F) and a focus group interview (Appendix G) was conducted to measure participant responsiveness and engagement (Dusenbury et al., 2013). Additionally, on the exit ticket survey, teachers responded to questions to measure the administration's support for the intervention (Appendix F). Furthermore, the researcher's journal collected qualitative data on the adherence of the intervention to the proposal (Appendix H).

Simultaneous with the qualitative data collection, the quantitative data was collected from the attendance and participation records. The posttest data was collected at the end of the intervention including quantitative data from the MKT instrument, the Teacher Efficacy Scale, and the MTEBI. In addition, qualitative data was gathered on teachers' experience participating in the mathematics PLC and coaching sessions after program implementation. Next, the researcher analyzed the data sets separately and independently from each other using quantitative and qualitative analytic procedures (Creswell & Plano-Clark, 2018). Once the researcher reached the point of interface, the researcher merged the results of the quantitative and qualitative data analysis to best answer the research questions (Creswell & Plano-Clark, 2018).

Pragmatism approves the use of a "combination of evaluation methods that best meet the needs of the evaluation questions…" (Mertens, 2018). Mixing methods can reflect a more robust and complete view of the phenomena by gaining the strengths of both quantitative and qualitative methods (Dures, Morris, Gleeson, & Rumsey, 2010). In triangulating the data through multiple data collection methods, one set of findings could validate the results from another set of findings (Creswell & Plano-Clark, 2018).

Strengths and Limitations of Design

A mixed methods approach to evaluation has several advantages. The triangulation of data combines quantitative outcome data about the effectiveness of the intervention with a deeper understanding of the mechanisms of change that lead to the quantitative outcomes (Mertens, 2018). The qualitative methods allowed the researcher to interview participants about their thoughts and feelings on the intervention, as well as report statistical trends (Creswell & Plano-Clark, 2018). The collection of the qualitative focus interview data alongside the quantitative pre-post data from the MKT instrument, MTEBI, and Teacher Efficacy Scale gave a more complete picture of the effectiveness of the intervention. Finally, mixed methods "supports the use of culturally responsive strategies to respectfully engage with a diverse set of stakeholders" (Mertens, 2018, p. 21). A mixed methods design has the capability to facilitate responsiveness to stakeholders who hold different levels of power within the school setting, increasing the possible use of findings for transformative purposes (Mertens, 2018). Mixed methods provided numerous opportunities for the use of data by various stakeholders throughout the evaluation process (Mertens, 2018).

Although there are many strengths associated with a mixed methods design, there are some limitations. The researcher had to be well versed in both quantitative and qualitative methods. Even after analyzing the data collected, it can be challenging to merge both sets of data and their results in a meaningful way (Creswell & Plano-Clark, 2018). To mitigate this barrier, the researcher designed the study so that the quantitative and qualitative data addressed the same concepts of pedagogical content knowledge and self-efficacy. This strategy helped facilitate the discussion of both data sets (Creswell & Plano-Clark, 2018). Additionally, the researcher faced the possibility of the quantitative and qualitative findings diverging (Creswell & Plano-Clark, 2018). However, the contradictions could provide new insights into teachers' pedagogical knowledge and self-efficacy. The researcher could resolve this issue by reflecting on the instruments selected, reexamining the data, collecting additional data and perhaps these findings will provide a springboard for future research. (Creswell, & Plano-Clark, 2018).

Internal validity refers to "inferences about whether observed covariation between A and B reflects a causal relationship from A to B in the form in which the variables were manipulated or measured" (Shaddish, Cook, & Campbell, 2002). The goal for this study was to determine if participating in mathematics PLCs and coaching changes the participants' pedagogical content knowledge and self-efficacy. However, there were threats that exist to the study's internal and external validity and a need for eliminating any rival hypotheses. As a result of using the mixed methods design with a pretest-posttest, the researcher was not able to describe a strong causal relationship, but the researcher was able to describe the change of the participants' pedagogical content knowledge and self-efficacy within this specific context from the pretest to posttest results of the MKT Instrument, MTEBI, and Teacher Efficacy Scale (Shaddish et al., 2002). The one-group pretest-posttest design provided a pretest measure of the outcome construct before the implementation of the treatment (Shaddish et al., 2002). The pretest data from the MKT instrument, MTEBI, and Teacher Efficacy Scale provide weak information about the counterfactual inference about what might have happened if the classroom teachers did not participate in the intervention (Shaddish et al., 2002). The change in teachers' pedagogical content knowledge and self-efficacy could be a result of other possible rival hypotheses instead of the intervention. For example, the pretest-posttest design is a testing threat to internal validity. The participants may gain some knowledge just by taking the test once and retaking the assessment for the posttest (Shaddish et al., 2002). The researcher minimized the test-retest bias by including multiple forms of the MKT instrument. In discussing external validity, the researcher was not able to make causal generalizations using the results of this study to a wider population because the researcher used a nonprobability sampling method (Pettus-Davis, Grady, Cuddeback, & Scheyett, 2011; Shaddish et al., 2002) and the study had a small sample size (Lochmiller & Lester, 2017).

This research aimed to fully explain the phenomena of the role of a mathematics PLC and coaching intervention changes teachers' pedagogical content knowledge, self-efficacy, and mathematics teaching self-efficacy within this context, give voice to the participants through qualitative methods, and effectively answer the research questions (Creswell & Plano-Clark, 2018; Mertens, 2018). As such, quantitative methods provided the outcome data, but qualitative data provided the explanation for the outcomes. The strengths gained from using a mixed methods design outweighed the limitations of this design and the strengths of using a single strand quantitative design.

Process Evaluation

To preserve the validity of the findings, the research monitored the study's fidelity of program implementation (Dusenbury, Brannigan, Falco, & Hansen, 2003). Conducting a process evaluation helped the researcher understand the connection between the program and the results of the study (Rossi, Lipsey, & Freeman, 2003). The research study questions addressed three process evaluation components: project implementation (Rossi et al., 2019), context (Stufflebeam, 2003), and participant responsiveness (Dusenbury et al., 2003).

Project implementation. Project fidelity is "the extent to which the services are consistent with the design of the program" (Rossi et al., 2019, p. 92). Adherence is part of measuring implementation fidelity (Dusenbury et al., 2003). Adherence is the "methods or implementation that conforms to theoretical guidelines" (Dusenbury et al., 2003, p. 240). It was important to measure adherence for this study to eliminate alternative possibilities and to develop causal statements for implementing mathematics PLCs and coaching sessions to increase teachers' pedagogical content knowledge.

A specific goal for this intervention was to enlist at least seven out of the nine available teachers, actively participating in all four mathematics PLCs, and all 12 coaching cycles. The researcher collected qualitative and quantitative data to measure adherence to the proposed timeline, number of sessions, content, and activities of the mathematics PLCs and coaching cycles. The adherence of project implementation was aligned to the logic model because this component allowed the researcher to track the adherence of the outputs. Rossi, Lipsey, and Henry (2019) define implementation fidelity as "the extent to which the program adheres to the program theory and design and usually includes such particulars as the amount of service received by the participants and the quality with which those services are delivered" (Rossi et al., 2019, p. 98). If these indicators are implemented with high fidelity and conform to the theoretical guidelines provided by the research, they should lead to the short and intermediate outcomes in the logic model over time. However, some of the distal outcomes are beyond the scope of the study.

Context. Context is the setting in "which the program functions" (Baranowski & Stables, 2000, p. 158). Context evaluations assess the "needs, problems, and opportunities with a define environment' (Stufflebeam, 2003, p. 31). It is important to identify the needs of the context for this study to develop and further refine the intervention to best meet the needs of the participants. A specific requirement for this intervention was to gain the support and participation from the school's administration in four out of the four mathematics PLCs. The researcher collected qualitative data from the perceptions of the participating teachers as to whether the school's administration was actively engaging in the mathematics PLCs and coaching sessions. The context evaluation was aligned to the logic model because this component allowed the researcher to track the input of administration support for the intervention. If this indicator is implemented with high fidelity, the engagement of administration should support teachers in progressing towards the outcomes listed in the logic model.

Participant responsiveness. Participant responsiveness is "ratings of the extent to which participants are engaged by and involved in the activities and content of the program" (Dusenbury et al., 2003, p. 244). By this definition, participants would be responsive if they attend and are actively engaged in all mathematics PLCs and coaching sessions. It was important to measure participant responsiveness for this study to evaluate if the participants find the intervention engaging, useful, and easily implemented into their mathematics instruction. A specific goal for all teachers was to actively participate in four out of the four mathematics PLCs, and 12 out of the 12 coaching cycles. The researcher collected qualitative and quantitative data to measure participant responsiveness through attendance and their level of participation. Participant responsiveness was aligned to the logic model because this component allowed the researcher to track teachers' degree of participation in the study.

Outcome Evaluation

A mixed methods research design provided the researcher with the strengths of both quantitative data to measure the change in teachers' pedagogical content knowledge and self-efficacy and the qualitative data to explain the participants' experience in participating in the intervention (Creswell & Plano-Clark, 2018). The mixed methods design yielded a complete and deeper understanding of the results of the study.

Quasi-experimental pretest-posttest method. The researcher manipulated participation in a combination of mathematics PLCs and coaching sessions during the intervention across two time points-pre and post (independent variable). To measure the change in the dependent variables of teachers' pedagogical content knowledge and self-efficacy in teaching mathematics, the researcher used a pretest-posttest design (Shaddish et al., 2002). The researcher used a one-group pretest-posttest design without a control group to best accommodate the small sample size of two (n=2) second-grade teachers. In the beginning of the 2020-2021 school year, the researcher collected quantitative pretest data using the MKT instrument (Hill et al., 2004), the Teacher Efficacy Scale (Gibson & Dembo, 1984), and the MTEBI (Althauser, 2015) to measure the teachers' level of pedagogical content knowledge and self-efficacy (Appendices A, B, and E, respectively). The mathematics PLC and coaching sessions focused on building teachers' pedagogical content knowledge of the upcoming standards through professional development on different strategies and questioning techniques. At the end of the intervention, the researcher conducted the outcome evaluation by administering the posttest of the MKT instrument, Teacher Efficacy Scale, and MTEBI, and conduct a focus group to discuss their experience in the program.

Method

ABC Elementary School is in Anne Arundel County, Maryland. The school serves 635 students from prekindergarten through fifth grade. About 60% of the school's population received free or reduced meal prices (ABC Elementary School Records, 2019). The study targeted classroom teachers who instruct mathematics in first- and second grade.

Participants

Convenience sampling was used to select individuals that are accessible to the researcher for the intervention study (Lochmiller & Lester, 2017). This study aimed to recruit seven out of the possible nine first- and second-grade teachers that are accessible to the researcher, but only two second grade teachers chose to participate. The sample include two white, female participants. The teaching experience varied from two to 14 years.

Measures or Instrumentation

This study investigated the extent to which participating in a combination of mathematics PLCs and coaching sessions changes teachers' pedagogical content knowledge and self-efficacy. In addition, the study examined the process of implementation for the intervention. Data collection measures included the pretest and posttest of the MKT instrument (Appendix A); Teacher Efficacy Scale (Appendix B); MTEBI (Appendix E); exit ticket surveys (Appendix F); a focus group (Appendix G); and field notes including a table to measure program adherence (Appendix H), attendance and participation log (Appendix I).

The purpose of the pretest and posttest surveys was to measure the participants' pedagogical content knowledge and self-efficacy in teaching mathematics. Additionally, the last section of the Teacher Efficacy Scale survey included demographic items such as years of teaching experience, what grade levels they have taught, and the percentage of students in their classroom who receive free or reduced prices.

Fidelity of Implementation

Observation and field notes. To examine the implementation of the intervention, data was collected using observations and field notes of the mathematics PLCs and coaching sessions. The data was collected by recording the date and time, the content, and activities that occurred during each of the mathematics PLCs and coaching sessions. In addition, the data was collected in a table to conduct a side-by-side comparison of the project plan versus what occurred during implementation. The table also included a column for the explanation as to why the researcher deviated from the original implementation plan. This indicator fit in with the logic model because the observational field notes tracked the adherence of the outputs. The field notes also enabled the researcher to track the adherence to the specific components of the intervention.

Exit ticket survey. The exit ticket survey was also used to evaluate project fidelity (Appendix F). The survey included a question asking participants "Did we meet the goals for this session?" This question acted as a formative evaluation and provided the researcher with information on how to improve future sessions.

Context

Exit ticket survey. The exit ticket survey evaluated the school administration's support for the professional development through the perceptions of the participating teachers (Appendix F). The survey included a question asking, "How did the administrators' attendance support the professional development?" This question provided the researcher with information on how important contextual factors, such as support from administration, influenced the effectiveness of the intervention.

Participant Responsiveness

Observations and field notes. Observations and field notes were also used to collect data on participants' responsiveness (Appendix I) to evaluate teachers' attendance and participation during the mathematics PLCs and coaching sessions. The data was collected in the attendance and participation record by documenting the date and time, if the participant was present or absent, and the number of times a teacher talked during the PLC session. This allowed the researcher to track the participation and engagement of the teachers in the study.

Exit ticket survey. The exit ticket survey not only evaluated a contextual factor, but the exit ticket survey also evaluated participant responsiveness (Appendix F). The survey included questions such as "On a scale from 0 to 5 (0 meaning completely disengaged and 5 meaning completely engaged), how engaged were you during this session?" What aspect of the session was most engaging? These questions acted as a formative evaluation and provided the researcher with information on how to improve future sessions.

Focus group. The semi-structured focus group evaluated the participant responsiveness during the program (Appendix G). This indicator fit well with the logic model because it allowed the researcher to analyze and reflect on the teachers' experience in the intervention. For example, the interview included questions such as "Did you feel the professional development provided by the mathematics PLC and coaching sessions were relevant to your practice as a mathematics teacher? Why or why not?" These responses provided the researcher with qualitative data on the participants' experience to improve future iterations of the intervention.

Pedagogical Content Knowledge

MKT. The MKT instrument was be used to measure each teacher's pedagogical content knowledge (Appendix A). The MKT instrument focused on number concepts and operations. On this survey, participants answered either 28 or 29 multiple choice questions on number concepts and operations, depending on the form they were randomly assigned. For the portion on number concepts and operations, Form A had 28 questions and Form B had 29 questions. Examples from this survey include "Which of these students would you judge to be using a method that could be used to multiply any two whole numbers?" and "Which of these students have the same kind of error?" The reliabilities for the scales, as well as for scales that combined number and operations items within each domain, were good to excellent, with a range from 0.71 to 0.84 (Hill et al., 2004).

Observations. The researcher conducted non-participant observations and minimized their interactions with the participants (Lochmiller & Lester, 2017). Each teacher participated in two observations during the intervention study. The first observation was conducted during the first coaching cycle and the second observation was conducted during the fourth coaching cycle. The observations were conducted during the lesson implementation session of the coaching cycles. The observational protocol provided a useful method to organize the observational data (Creswell & Plano-Clark, 2018) (Appendix C). Field notes were recorded as verbatim transcripts. Each mathematics lesson was approximately thirty to forty-five minutes in length.

Focus group. The semi-structured focus group evaluated the change in participants' pedagogical content knowledge in mathematics as a result of the intervention (Appendix G). This indicator fit well with the logic model because it allowed the researcher to analyze and reflect on the teachers' experience in the intervention. For example, the interview included questions such as "How did participation in the mathematics PLCs and coaching sessions affect your pedagogical content knowledge?" and "What strategies learned during the mathematics PLC and coaching sessions were most effective in your classroom?" These responses provided the researcher with qualitative data on the participants' experience to improve future iterations of the intervention.

Teacher Self-Efficacy

Teacher Efficacy Scale. The 30-item Teacher Efficacy Scale (Appendix B) is an existing survey (Gibson & Dembo, 1984). The survey is designed to measure each teacher's beliefs about their ability to affect student achievement. On this survey, participants responded by indicating their self-efficacy about teaching by using a six-point Likert scale ranging from 1 *strongly disagree* to 6 *strongly agree.* Examples from this survey included "The hours in my class have little influence on students compared to the influence of their home environment" and "When the grades of my students improve it is usually because I found more effective teaching approaches." An analysis of reliabilities yielded Cronbach's alpha coefficients resulted in .78 for the Personal Teaching Efficacy factor, .75 for the Teaching Efficacy factor, and .79 for all the items (Gibson & Dembo, 1984) (Appendix B).

Math Teaching Efficacy Beliefs

Math teaching efficacy beliefs instrument. The 25-item MTEBI (Appendix E) is an existing survey (Althauser, 2015). The survey is designed to identify teachers' self-reported efficacy in teaching mathematics. On this survey, participants responded by indicating their self-efficacy about teaching by using a six-point Likert-type scale ranging from 1 *strongly* *disagree* to 6 *strongly agree.* Examples from this survey included "When a low-achieving child progresses in math, it is usually due to extra attention given by the teacher" and "I am not very effective in monitoring math achievement through hands-on activities." An analysis of reliabilities yielded Cronbach's alpha coefficients resulted in pre-training measures ranging from .74 to .90 and post-training measures ranging from .69 to .82 (Althauser, 2015) (Appendix E).

Focus group. The semi-structured focus group examined changes in their self-efficacy in teaching mathematics as a result of participating in the intervention (Appendix G). For example, the interview included questions such as "How confident do you feel in your ability to effectively teach mathematics to your students? How has your participation in the mathematics PLC and coaching sessions influenced your ability to meet the needs of your students during mathematics instruction?" The responses from the participants provided the researcher with an in-depth understanding of how the program changed the participants' self-efficacy in teaching mathematics to improve future iterations.

Procedure

PLCs and coaching program. The intervention, which included online mathematics PLCs and coaching sessions occurred from January through April of the 2020-2021 school year. The online mathematics PLCs were implemented once a month for a 60-minute time frame, totaling four hours. Each classroom teacher participated in three 30-minute online coaching sessions per month, totaling six hours. The topics focused on building teachers' pedagogical content knowledge for upcoming mathematics standards and strengthening the teachers' questioning to include more *focusing* questions. *Focusing* questions emphasize student thinking to support higher levels of cognitive demand (MGatha et al., 2018). Table 4.1 and 4.2 below offers an overview of the intervention timeline that included the mathematics standards addressed, strategies taught, and the data collection for each session.

The structure of the mathematics PLCs followed the six characteristics of an effective PLC. The first characteristic focused on a supportive and shared leadership among those participating in the PLC (DuFour, 2004). Both administrators were invited to every mathematics PLC meeting through a Google invitation the week prior to the session. Administrator participation is necessary to implement a school structure that will support teachers' work (Hoy and Sweetland, 2001) and the decision-making process (DuFour, 2004). The second characteristic described the importance of a shared vision between members (DuFour, 2004; Gee & Whaley, 2016). Our district's shared vision is to ensure an accessible, high quality mathematics education through a community of mathematically proficient learners who continually find the beauty of mathematics and all the opportunities mathematics affords (Anne Arundel County Public Schools, 2020). The third characteristic detailed how collective learning and the application of learning among is imperative to developing effective solutions to meet the needs of the students (Desimone, Porter, Garet, Yoon, & Birman, 2002; DuFour, 2004; Gee & Whaley, 2016). The teachers worked together to brainstorm and share activities and strategies to best meet the students' needs based the data shared during the PLC. The teachers then applied these strategies in their classrooms with the support of the coaching sessions. The fourth attribute of a PLC described the importance of a sensitive and encouraging learning environment (DuFour, 2004; Gee & Whaley, 2016). The mathematics PLC and coaching environment held a collaborative and supportive atmosphere by valuing the participants' voices and sharing the decision-making process (DuFour, 2004; Gee & Whaley, 2016). The fifth aspect valued shared practice (DuFour, 2004; Gee & Whaley, 2016). This characteristic was clearly implemented during the coaching sessions between the researcher and the participant. The researcher supported the improvement of both participants through building pedagogical content knowledge, preplanning lessons, conducting observations, and providing feedback (DuFour, 2004; Gee & Whaley, 2016). Finally, the last characteristic of an effective PLC discussed the importance of having a results orientation (Desimone et al., 2002; DuFour, 2004). The informal data collected during daily instruction and standardized mathematics data drove future discussions during mathematics PLC and coaching sessions.

The characteristics of an effective PLC will drove the lesson plans for each of the sessions. The activities planned for the mathematics PLCs focused on collective learning, having a results orientation, and shared decision making (Desimone et al., 2002; DuFour, 2004; Gee & Whaley, 2016). Each mathematics PLC began with the goals for that session. Then, teachers collectively learned about the upcoming content standards, shared strategies and activities, and preplanned focusing questions to build pedagogical content knowledge. Next, the members of the PLC shared in the decision-making process by discussing their next instructional steps. The mathematics PLC ended with the completion of the exit ticket survey. The coaching sessions focused on the characteristics of shared practice and the application of learning (DuFour, 2004; Gee & Whaley, 2016), with an emphasis on mathematics content and pedagogy (Desimone & Pak, 2017). The type of coaching implemented by the researcher was differentiated based on the needs of each individual participant. During the first monthly coaching session, the coach and participant planned a lesson to apply the new learning gained from participating in the mathematics PLC. During this lesson, the coach either observed, modeled, or co-taught and provided feedback to the participant. The second monthly coaching session was the implementation of the planned lesson. The third monthly coaching session was the discussion between the coach and participant about the feedback on the lesson implemented.

Table 4.1

First Grade Overview and Timeline of the PLC meetings

Session & Date	Collective Learning: Standards/Strategies Results Orientation: Student Data Focus	Data Collection
Pre-session: January 11, 2021	n/a	Pretest Administration (MKT instrument, Teacher Efficacy Scale, and MTEBI)
Session 1: January 27, 2021	Collective Learning: Addition and subtraction within ten fluently and within 20/Number path, commutative property, and connecting addition to subtraction Results Orientation: Fluency Check 1	Exit ticket survey and record data in researcher's journal on adherence, attendance, and participation
Session 2: February 24, 2021	Collective Learning: Addition within 100 and subtracting multiples of ten/Using 120 chart Results Orientation: Fluency Check 2	Exit ticket survey and record data in researcher's journal on adherence, attendance, and participation
Session 3: March 23, 2021	Collective Learning: Compare two-digit numbers and addition within 100/Using base ten blocks Results Orientation: iReady Diagnostic Assessment	Exit ticket survey and record data in researcher's journal on adherence, attendance, and participation

Session 4: April 21, 2021	Collective Learning: Addition within 100 (addition of a two-digit number and a one-digit number)/Numberless word problems Results Orientation: Fluency Check 4	Exit ticket survey and record data in researcher's journal on adherence, attendance, and participation
Post-session: April 30, 2021	n/a	Focus group and posttest administration

Table 4.2

Second Grade Overview and Timeline of the PLC meetings

Session & Date	Collective Learning: Standards/Strategies Results Orientation: Student Data Focus	Data Collection
Pre-session: January 11, 2021	n/a	Pretest Administration (MKT instrument, Teacher Efficacy Scale, and MTEBI)
Session 1: January 13, 2021	Collaborative Learning: Addition and subtraction within 20 fluently and within 100/Decomposition, open number line, and regrouping Results Orientation: Fluency Check 1	Exit ticket survey and record data in researcher's journal on adherence, attendance, and participation
Session 2: February 10, 2021	Collaborative Learning: Place value, ten or 100 more, and ten or 100 less than any number between 100-900/Using base ten blocks Results Orientation: Fluency Check 2	Exit ticket survey and record data in researcher's journal on adherence, attendance, and participation

Session 3: March 9, 2021	Collaborative Learning: Ordering numbers and skip counting by 5's/Using 120 chart Results Orientation: iReady Diagnostic Assessment	Exit ticket survey and record data in researcher's journal on adherence, attendance, and participation
Session 4: April 7, 2021	Collaborative Learning: Addition and subtraction within 20 fluently, name and value of money/Using coins and a number line Results Orientation: Fluency Check 4	Exit ticket survey and record data in researcher's journal on adherence, attendance, and participation
Post-session: April 30, 2021	n/a	Focus group and posttest administration

Teacher recruitment for the study began in mid-December, and the intervention began in January. Teachers were recruited by email by the researcher. The recruitment email described the purpose of the study and the requirements for the participants. The mathematics PLC sessions were a collaborative, data driven, and supportive environment which provided teachers with effective pedagogical strategies and questioning techniques for the upcoming standards. The coaching sessions were differentiated based on the needs of the individual teacher and focused on the application of these new skills in the classroom through shared practice. A sample session mathematics PLC presentation is provided in Appendix J.

Data Collection and Analysis

Data collection for this study began with the administration of both pretest surveys in December of the 2020-2021 school year. The summary matrix includes each research question, constructs, instruments, and data analysis details in Appendix K. For each source of data, the summary matrix provides the specific data collection procedures.

RQ1: To what extent did the intervention adhere to the proposed timeline, number of sessions, content, and activities of the mathematics PLCs and coaching cycles?

Field notes. During each mathematics PLC and coaching session, the researcher gathered data in a comparison table on whether each session adhered to the planned implementation. The comparison table included columns for the proposed session date, the mathematics standards and strategies planned, the actual session date and the actual mathematics standards and strategies taught. The researcher also included a column for notes to explain why the researcher may have to deviate from the original session plans for later reference. The researcher's journal provided important information for the process evaluation to improve future iterations of the program. A sample of the comparison table is in Appendix H.

To answer this research question, descriptive coding was used to summarize key segments of qualitative data in the notes section of the comparative table (Lochmiller & Lester, 2017). These codes were grouped into categories and then themes to identify overarching trends in the data (Lochmiller & Lester, 2017). The recorded sessions allowed the researcher to determine how much the researcher adhered to or deviated from the original implementation. This will be helpful for program scale-up and to provide findings for those who are considering this program in another context (Shaddish et al., 2002).

Exit ticket survey. At the end of each mathematics PLC session, participants completed an exit ticket survey. The exit ticket survey was conducted through Survey Monkey and was emailed to the participants at the conclusion of each session. The data collected by the survey provided valuable information on project fidelity during the intervention. A sample exit ticket survey is in Appendix F. The exit ticket surveys were read after each mathematics PLC meeting to monitor the feedback and to adjust future sessions to best meet the needs of the participants. The project fidelity item created for the process evaluation was analyzed using descriptive statistics.

RQ2: How did teachers describe the administration's support of the intervention?

Exit ticket survey?

At the end of each mathematics PLC session, participants completed an exit ticket survey. The exit ticket survey was conducted through Survey Monkey and was emailed to the participants at the conclusion of each session. The data collected by the survey provided valuable information on the contextual support for the intervention, specifically support from the school's administration. A sample exit ticket survey is in Appendix F. For the process evaluation, exit ticket surveys were reviewed after each session to monitor progress support from administration. Participant feedback on the contextual items about administrations' engagement were analyzed using emergent, descriptive coding to conduct a thematic analysis of the data (Lochmiller & Lester, 2017). This data helped the researcher in measuring the administrators' engagement and support through the perceptions of the participants.

RQ3: What was the level and quality of participant engagement in the mathematics PLCs and coaching cycles?

Field notes. During each mathematics PLC and coaching session, the researcher took field notes to record the teachers' attendance and participation. The table included a column for the session number, participant number, and number of times a teacher participates. Participation was measured by recording a tally mark each time a teacher participates during the session. The researcher's journal provided important information for the process evaluation to measure teacher engagement in the intervention. A sample of the attendance and participation log is found in Appendix I.

To answer the research question, descriptive statistics was used to measure the level of participant engagement in the PLC and coaching sessions. The quantitative analysis included descriptive statistics. To answer this research question, frequencies and calculating the mean was used to compare participation levels between each of the sessions. The data gained from measuring participant responsiveness was helpful feedback for future sessions, in scaling up the intervention in the future, and for those who are considering this program in another context (Shaddish et al., 2002).

Exit ticket survey. At the end of each mathematics PLC session, participants completed an exit ticket survey. The exit ticket survey was conducted through Survey Monkey and was emailed to the participants at the conclusion of each session. The data collected by the survey provided valuable information on participant responsiveness during the intervention. A sample exit ticket survey is in Appendix F. The exit ticket surveys were read after each mathematics

PLC meeting to monitor the feedback and to adjust future sessions to best meet the needs of the participants. Participant responsiveness items created for the process evaluation were analyzed using descriptive statistics and descriptive coding. Descriptive coding allowed the researcher to identify common trends across the participant group and to make the necessary changes to improve the program (Lochmiller & Lester, 2017).

Focus group. At the end of the intervention in April, the researcher conducted a semi-structure focus group interview with the participating second-grade teachers. The focus group protocol is included in Appendix G. The focus group protocol included the introductory script, questions, and the concluding script. Although the researcher took notes during and after the focus group interview, the interview was recorded for verbatim transcription. To protect the identity of the participants, the recording was deleted after the transcription process was completed.

During the focus group interview, the participants shared their experiences in the mathematics PLC and coaching program. The researcher took notes throughout the interview to provide in-depth qualitative data (Braun & Clark, 2006). The data collected from the focus group interview provided a deeper understanding of the participants' level and quality of engagement during the intervention. Participants shared what activities were most engaging and which were least engaging. Emergent, descriptive coding was used to conduct a thematic analysis of the focus group data (Lochmiller & Lester, 2017). The themes revealed helped the researcher in effectively answering the research question about participant engagement.

RQ4: How did participating in mathematics PLCs and coaching cycles change teachers' pedagogical content knowledge?

MKT instrument. The MKT instrument will be used to measure teachers' pedagogical content knowledge in mathematics after their participation in the mathematics PLC and coaching sessions. The multiple-choice instrument will include 28 or 29 number concepts and operations questions based on the form that has been randomly selected for the pretest and posttest administration. A sample of the MKT instrument items is included in Appendix A.

The pretest and posttest data were entered into the Statistical Package for Social Science (SPSS) data analysis program. Descriptive statistics was used to compare the pretest data to the posttest data. To answer the research question, data analysis compared the pretest mean to the posttest mean. Furthermore, the analysis compared each participants' pretest score to their posttest score. This analysis will show the change of each individual teacher and the group as a whole.

Focus group. At the end of the intervention in April, the researcher conducted a semi-structured focus group interview with the participating second-grade teachers. The focus group protocol is included in Appendix G. The focus group protocol included the introductory script, questions, and the concluding script. Although the researcher took notes during and after the focus group interview, the interview was recorded for verbatim transcription. To protect the identity of the participants, the recording was deleted after the transcription process was completed.

During the focus group interview, the participants shared their experiences in the mathematics PLC and coaching program. The researcher took notes throughout the interview to provide in-depth qualitative data (Braun & Clark, 2006). The participants were asked to share what strategies they learned during the program were most effective and which were the least effective. The qualitative data collected from the focus group interview was paired with the quantitative results from the MKT instrument to create a deeper understanding of the phenomena. Emergent, descriptive coding was used to conduct a thematic analysis of the focus group data (Lochmiller & Lester, 2017). The themes revealed helped the researcher in seeking if the intervention had an influence on teachers' pedagogical content knowledge in mathematics.

RQ5: How did teachers' level of self-efficacy change after participating in mathematics PLCs and coaching sessions?

Teacher Efficacy Scale. The Teacher Efficacy Scale was used to measure teachers' self-efficacy after their participation in the mathematics PLC and coaching sessions. The Likert scale survey included 30 items for the teachers to respond to. The Teacher Efficacy Scale asked participants to what level do they agree or disagree with statements such as "When a student is having difficulty with an assignment, I am usually able to adjust it to his/her level" or "If a student did not remember information I gave in a previous lesson, I would know how to increase his/her retention in the next lesson" (Gibson & Dembo, 1984). The Teacher Efficacy Scale is included in Appendix B.

The pretest and posttest data were entered into the SPSS data analysis program. Descriptive statistics was used to compare the pretest data to the posttest data. To answer the research question, data analysis compared the pretest mean to the posttest mean. Furthermore, the analysis compared each participants' pretest score to their posttest score. This analysis will show the change (if any) in self-efficacy of each individual teacher and of the whole sample.

a. How did teachers' level of mathematics teaching efficacy beliefs change after participating in mathematics PLCs and coaching sessions?

Math teaching efficacy beliefs instrument. The MTEBI was used to measure the participants' self-efficacy in teaching mathematics after their participation in the mathematics PLC and coaching sessions. The Likert scale survey included 25 items for the teachers to respond to. The MTEBI asked participants to what level do they agree or disagree with statements such as "I am typically able to answer students' math questions" or "Increased effort in math teaching produces little change in some students' math achievement" (Althauser, 2015). The MTEBI is included in Appendix E.

The pretest and posttest data were entered into the SPSS data analysis program. Descriptive statistics was used to compare the pretest data to the posttest data. To answer the research question, data analysis compared the pretest mean to the posttest mean. Furthermore, the analysis compared each participants' pretest score to their posttest score. This analysis will show the change (if any) in self-efficacy in teaching mathematics of each individual teacher and of the whole sample.

Focus group. At the end of the intervention in April, the researcher conducted a semi-structured focus group interview with the participating second-grade teachers. The focus group protocol is included in Appendix G. The focus group protocol included the introductory script, questions, and the concluding script. Although the researcher took notes during and after the focus group interview, the interview was recorded for verbatim transcription. To protect the identity of the participants, the recording was deleted after the transcription process was completed.

During the focus group interview, the participants shared their experiences in the mathematics PLC and coaching program. The researcher took notes throughout the interview to provide in-depth qualitative data (Braun & Clark, 2006). The participating teachers were asked to share how confident they feel in teaching mathematics to their students and how their participation in the mathematics PLC and coaching sessions has influenced their ability to meet the needs of their students during mathematics instruction. The data collected from the focus group interview was paired with the quantitative results from the Teacher Efficacy Scale and MTEBI to develop an in-depth understanding of the teachers' confidence level in teaching mathematics. Emergent, descriptive coding was used to conduct a thematic analysis of the focus group data (Lochmiller & Lester, 2017). The themes revealed provided the researcher with qualitative data to effectively answer if the program had an influence on teachers' level of self-efficacy in teaching mathematics.

Triangulation of quantitative and qualitative data. The data analysis for this evaluation study design entailed triangulation of quantitative and qualitative data. Triangulation of multiple data collection methods helped the researcher validate the results or find instances of divergence (Lochmiller & Lester, 2017). In the case of diverging datasets, the researcher will use this information to reflect on instrumentation and provide a springboard for future research. Qualitative data collection methods such as the focus group interview helped provide an explanation for the quantitative results from the MKT instrument, the Teacher Efficacy Scale and MTEBI. Triangulation of methods not only assisted the researcher in effectively answering the mixed methods research questions, this technique also helped in strengthening dependability (Shenton, 2004). To ensure the credibility of the data collected and the interpretations of the data, the researcher implemented member checking with the participants (Guba, 1981).

Situated learning theory. The researcher situated and interpreted the findings with respect to the theoretical framework, situated learning theory. When the researcher analyzed the feedback provided by the exit ticket survey and focus group interview, the data revealed which activities were most effective from the participants' perspective. Additionally, the researcher asked the participants if they feel their pedagogical content knowledge and self-efficacy in teaching mathematics has changed as a result of program participation. For example, if teachers respond that they found collaborative learning and shared practice with upcoming standards in PLCs and coaching sessions most effective in increasing their pedagogical content knowledge and self-efficacy, the researcher could connect this result as a consequence of socially constructing knowledge (Lave & Wenger, 1991), in an authentic context (Orgill, 2007).

CHAPTER 5

Research Findings and Implications

The purpose of this dissertation was to examine first and second grade classroom teachers' pedagogical content knowledge and self-efficacy in teaching mathematics through participation in a PLC and coaching cycles. Chapter 3 discussed possible interventions to support the problem of practice that elementary school students who receive free or reduced meal prices underperform compared to their more affluent peers on standardized mathematics assessments (Gamoran & Long, 2006; Morgan et al., 2016). The researcher addressed the problem of practice and the following research questions through a virtual professional learning community and one-on-one coaching sessions. This chapter will present the research findings and discuss the implications of the results. The following research questions will guide the analyses within chapter five:

Process Evaluation

RQ1: In what ways did the intervention adhere to the proposed timeline, number of sessions, content, and activities of the mathematics PLCs and coaching cycles?

RQ2: How did teachers describe the administration's support of the intervention?

RQ3: What was the level and quality of participant engagement in the mathematics PLCs and coaching cycles?

Outcomes Evaluation

RQ4: How did participating in mathematics PLCs and coaching cycles change teachers' pedagogical content knowledge?

RQ5: How did teachers' sense of self-efficacy change after participating in mathematics PLCs and coaching sessions?

a. How did teachers' mathematics teaching efficacy beliefs change after participating in mathematics PLCs and coaching sessions?

Research Question 1

RQ1: In what ways did the intervention adhere to the proposed timeline, number of sessions, content, and activities of the mathematics PLCs and coaching cycles?

A specific goal for the intervention was to enlist at least seven out of the nine available teachers, actively participating in four out of the four mathematics PLCs, and 12 out of the 12 coaching cycles. The researcher was only able to recruit two out of the nine participants, however, the participating teachers did attend all four PLC and all 12 coaching cycle sessions. From the exit ticket survey results, both participants responded that we met the goals for every session. This section will examine project fidelity by discussing the actual implementation of the program compared to the planned program.

Session 1

The pre-session and session 1 occurred in early January 2021. The PLC for session 1 lasted for 55 minutes, compared to the planned 60 minutes. With the virtual learning schedule, the administration from ABC Elementary School reduced the amount of time dedicated to the PLC sessions. Both participants were present for the pre-session and session 1 activities. All professional learning community members received the mathematics PLC agenda, a copy of the student assessment, and the directions on how to score and store the data a week in advance for the meeting. The researcher used a PowerPoint to guide the professional learning community via the Google Meet platform. At the beginning of the PLC, the goals for session 1 were shared with both members. In session 1, the researcher shared historical fluency data, provided an overview of the fluency standards, modeled the appropriate Number Sense Routines, provided an overview of the various types of questioning and the phases of fluency. The PLC members participated in analyzing student work samples, discussed next steps, and activities for fluency practice. The researcher shared a preview of the next PLC session which focused on the second-grade content standards centered around place value.

After the completion of the session 1 PLC, the researcher reached out to schedule the first coaching cycle with each participant. Both teachers participated in all three planned sessions of the first coaching cycle (planning session, observation, and lesson debrief). As described in the plan, the session 1 coaching cycle focused on building teachers' pedagogical content knowledge of the upcoming standards through professional development on different strategies and questioning techniques. Both teachers brought a lesson from the curriculum they wanted to implement from the second grade fluency standard of solving addition and subtraction within 20 with regrouping. The researcher guided the teachers on how to implement the lessons with fidelity using the strategies of using an open number line and decomposition, while specifically planning questions to ask students. The questions planned by the researcher and the participant were strategically chosen to guide their students through the phases of fluency shared at the PLC session. The researcher conducted the first classroom observation during the lesson implementation phase of the coaching cycle using the observation protocol (Appendix C). During the third coaching session, the researcher asked the participants how they felt the lesson went and the researcher shared strategies and questioning techniques that went well and areas that will be focused on for the second coaching cycle. The researcher specifically shared the number of IRF, funneling, and focusing questions the participant asked during the classroom observation. In examining project fidelity for session 1, all proposed plans were implemented with consistency except for the planned time frame of 60 minutes.

Session 2

Session 2 occurred in early February 2021. The PLC for session 2 lasted for 55 minutes, compared to the planned 60 minutes. Both participants were present for the session 2 activities. All professional learning community members received the mathematics PLC agenda, a copy of the student assessment, and the directions on how to score and store the data a week in advance for the meeting. The researcher used a PowerPoint to guide the professional learning community via the Google Meet platform. At the beginning of the PLC, the goals for session 2 were shared with all members. In session 2, the researcher shared historical data on place value standards, provided an overview of the second-grade place value standards, modeled how to use base ten blocks, and provided an overview of the various types of questioning that would be effective in eliciting students' higher level thinking skills for these standards. The PLC members participated in analyzing student work samples, discussed next steps, and shared activities for students to practice finding ten or 100 more and ten or 100 less than any number between 100 and 900. The researcher shared a preview of the next PLC session which focused on ordering numbers and skip counting by fives.

After the completion of the session 2 PLC, the researcher reached out to schedule the second coaching cycle with each participant. Both teachers participated in all three planned sessions of the second coaching cycle (planning session, lesson implementation, and lesson debrief). As described in the plan, the session 2 coaching cycle focused on building teachers' pedagogical content knowledge of the upcoming standards through professional development on different strategies and questioning techniques. Both teachers brought a lesson from the curriculum they wanted to implement from the second-grade place value standard. The researcher guided the teachers on how to implement the lessons with fidelity using the strategy of base ten blocks, which was shared at the PLC session, while specifically planning higher level questions to ask the students. During both participants' lesson implementation phases, the researcher began each lesson with modeling how to appropriately use the base ten blocks with students to show how to find ten or 100 more, and ten or 100 less than any number between 100 and 900, while modeling the appropriate questioning techniques. For the remainder of the lesson, the participants co-taught the lesson with the researcher. During the third coaching session, the researcher asked the participants how they felt the lesson went and the researcher shared how the participant did with using base ten blocks as a strategy to help their students with the place value standard. Further, the researcher shared the questioning techniques that went well and areas that will be focused on for the third coaching cycle. In examining project fidelity for session 2, all proposed plans were implemented with consistency except for the planned time frame of 60 minutes.

Session 3

Session 3 occurred in early March 2021. The PLC for session 3 lasted for 55 minutes, compared to the planned 60 minutes. Both participants were present for the session 3 activities. All professional learning community members received the mathematics PLC agenda, a copy of the student assessment, and the directions on how to score and store the data a week in advance for the meeting. The researcher used a PowerPoint to guide the professional learning community via the Google Meet platform. At the beginning of the PLC, the goals for session 3 were shared with all members. In session 3, the researcher shared historical data, provided an overview of the second-grade content standards centered on ordering numbers and skip counting, modeled how to use the 120 chart, and provided an overview of the various types of questioning that would be effective in eliciting higher level thinking skills from their students. The PLC members participated in analyzing student work samples, discussed next steps, and activities for further practice on ordering numbers and skip counting. The researcher shared a preview of the next PLC session which focused on addition and subtraction within 20 fluently, and naming and identifying the value of money.

After the completion of the session 3 PLC, the researcher reached out to schedule the third coaching cycle with each participant. Both teachers participated in all three planned sessions of the third coaching cycle (planning session, lesson implementation, and lesson debrief). As described in the plan, the session 3 coaching cycle focused on building teachers' pedagogical content knowledge of the upcoming standards through professional development on different strategies and questioning techniques. Both teachers brought a lesson from the curriculum they wanted to implement on ordering numbers and skip counting by fives. The researcher guided the teachers on how to implement the lessons with fidelity using the 120 chart, which was shared at the PLC session. Additionally, the researcher and the participant worked collaboratively to specifically plan higher level questions to ask the students. During both participants' lesson implementation phases, the researcher and the participant co-taught the lesson and implemented the questions planned during the lesson planning session. During the coaching session debrief, the researcher asked the participants about their perceptions of the lesson. Further, the researcher shared the questioning techniques that went well and areas that will be focused on for the final coaching cycle. In examining project fidelity for session 3, all proposed plans were implemented with consistency except for the planned time frame of 60 minutes.

Session 4

Session 4 occurred in early April 2021. The PLC for session 4 lasted for 55 minutes, compared to the planned 60 minutes. Both participants were present for the session 4 activities. All professional learning community members received the mathematics PLC agenda, a copy of the student assessment, and the directions on how to score and store the data a week in advance for the meeting. The researcher used a PowerPoint to guide the professional learning community via the Google Meet platform. At the beginning of the PLC, the goals for session 4 were shared with all members. In session 4, the researchers shared historical fluency data, provided an overview of the content standards focused on fluency within 20 and money, modeled how to use fake coins and a number line to effectively teach the standards, and provided an overview of the various types of questioning to elicit higher level thinking from students. The PLC members participated in analyzing student work samples, discussed next steps, and activities for fluency practice.

After the completion of the session 4 PLC, the researcher reached out to schedule the final coaching cycle with each participant. Both teachers participated in all three planned sessions of the fourth coaching cycle (planning session, lesson implementation, and lesson debrief). As described in the plan, the session 4 coaching cycle focused on building teachers' pedagogical content knowledge of the upcoming standards through professional development on different strategies and questioning techniques. Both teachers brought a lesson from the curriculum they wanted to implement. For this coaching session, they focused on fluency and money standards. The researcher guided the teachers through how to implement the lessons with fidelity by using the strategies of using coins and a number line. The researcher and the participants collaborated on planning higher level questions, specifically focusing questions, to ask their students. The researcher conducted the final classroom observation during the lesson implementation phase of the coaching cycle using the observation protocol (Appendix C). During the coaching session debrief, the researcher asked the participants how they felt the lesson went and the researcher shared strategies and questioning techniques that went well. The researcher also shared areas we could work on for future growth (beyond the scope of the study). Additionally, the researcher shared the growth each participant made in questioning from the first coaching session to the final coaching session. In examining project fidelity for session 4, all proposed plans were implemented with consistency except for the planned time frame of 60 minutes.

Fidelity of Implementation: A Summary

For fidelity of implementation (RQ1) to be met, the intervention must adhere to the proposed timeline, the number of sessions, the content, and the activities of the math PLCs and coaching sessions. The professional learning community and coaching sessions were presented as designed, in terms of the proposed timeline, activities, and number of sessions. Attendance from both participants was consistent for all professional learning community sessions, coaching sessions, completion of instruments, and the focus group interview. Additionally, both participants attended the sessions for the full duration. However, as a consequence of the COVID-19 pandemic, the virtual learning schedule did not allow for the full 60-minute PLC session to be implemented with fidelity. Although the participants shared all goals were met for each session, the researcher noted feeling rushed at the end of each PLC session and the participants shared the need for more time for the implementation of the intervention during the focus group interview (Participant 1, Focus Group Interview; Participant 2, Focus Group Interview).

Conclusions. Overall, the intervention was implemented with high fidelity. The PLC and coaching sessions were implemented as planned, including the proposed timeline, number of sessions, dosage, content, and activities. Other components of fidelity of implementation including contextual support and participant responsiveness will be discussed within the findings for research questions 2 and 3.

Research Question 2

RQ2: How did teachers describe the administration's support of the intervention?

A goal of this study was for the school's administration to participate in all 4 PLC sessions. According to the field notes taken on the administration's attendance, the assistant principal of ABC Elementary School attended two out of the four PLC sessions for the full duration of the meeting. For one of the four PLC meetings, the assistant principal joined after the first 30 minutes of the session (Table 5.1). The principal of ABC Elementary School did not attend any of the PLC sessions. The quantitative data collected from the exit ticket survey on the administration's engagement in the PLC sessions were analyzed using descriptive statistics.

The mean level of engagement for the PLC sessions attended by the assistant principal was 3.67 (M=3.67), on a scale from zero to five (zero meaning completely disengaged and five meaning completely engaged) (Table 5.1).

Table 5.1

Administration Participation Levels, N = 2

Attendance at PLC	N (%)	Mean Level of Engagement
Session 1	1 (50)	3.5
Session 2	0 (0)	N/A
Session 3	1 (50)	4
Session 4	1 (50)	3.5

Additionally, the qualitative data gathered by the exit ticket survey were analyzed using descriptive coding. The descriptive codes were used to develop the theme of participation from the data (Lochmiller & Lester, 2017). The exit ticket survey data indicated codes of *adding ideas, support, and lack of participation* (Table 5.2).

Table 5.2

Codebook

Theme	Code	Definition	Example
Participation	Adding ideas	The administrator offered ideas on how to implement math strategies.	"Gave ideas on how to implement strategies in the classroom" (Teacher respondent, personal communication, February 16, 2021)
	Support	The administrator offered support to implement various	"Adding input from administrator point of view" (Teacher

	strategies in the classroom.	respondent, personal communication, April 14, 2021)
Lack of participation	The administrator did not participate in the professional learning community.	“Pretty quiet, didn’t have much to add” (Teacher respondent, personal communication, January 27, 2021)

Participation. The theme, **participation**, refers to the different types of participation administration used during the PLC sessions as described by the teachers and includes the codes *adding ideas, support, and lack of participation.* Although the principal of ABC Elementary School did not attend any of the PLC sessions (0%), the assistant principal attended three (75%) out of four PLC sessions for at least half of the duration of the meeting. The principal did not attend any of the PLC sessions because there were both reading and math PLC sessions running simultaneously because of the virtual learning schedule. The principal attended the reading PLC sessions, and the assistant principal attended the math PLC sessions. During the three sessions attended by the assistant principal, the code *adding ideas* was developed and defined as offering ideas on how to implement math strategies. (Table 5.2). For example, on the Exit Ticket Survey for PLC session 1, one respondent noted the assistant principal “gave ideas on how to implement strategies in the classroom” (Teacher respondent, personal communication, February 16, 2021). Additionally, on the Exit Ticket Survey for PLC session 4, one participant shared the assistant principal “provided suggestions” (Exit Ticket Survey). In the field notes for sessions 1 and 4, when the teachers expressed time restraint concerns, the researcher mentioned the assistant principal offered ideas on when the teachers could implement Number Sense Routines and fluency practice (during flex and flourish time).

Furthermore, the mean engagement score for session 1 and for session 4 was a 3.5 out of 5 on a Likert scale which shows how the participants rated the administrator's participation in the PLC sessions (Table 5.1).

In two (67%) out of the three PLC sessions, where the assistant principal attended at least half of the duration of the meeting, a code of *support* was developed through the descriptive coding process. The code of *support* is defined as offering support to implement various strategies in the classroom (Table 5.2). For example, on the Exit Ticket Survey for PLC session 3, one respondent noted the assistant principal "add[ed] ideas and support" (Exit Ticket Survey). To support this statement, the mean engagement score was a 4 out of 5 on a Likert scale for the administrator's engagement in this PLC session (Table 5.1). This is the highest mean administrator engagement score out of all four PLC sessions (Table 5.1). Additionally, on the Exit Ticket Survey for PLC session 4, one participant shared the assistant principal "add[ed] input a from administration point of view" (Teacher respondent, personal communication, April 14, 2021). The data from the exit ticket survey reveals the teachers felt supported in implementing the strategies and activities discussed in the PLC sessions. This is reflective of the literature on the characteristics of an effective PLC. The first characteristic discussed by DuFour (2004) is the importance of a supportive and shared leadership among those participating in the PLC. Administrator participation was necessary to implement a school structure that supported the teachers' work (Hoy and Sweetland, 2001) and the decision-making process (DuFour, 2004).

Although the vast majority (83.33%, n=5) of the assistant principal's engagement scores were rated a three or more, there was one session where a participant rated the assistant principal's engagement as a two out of five. Through the descriptive coding process, a code of *lack of participation* was developed. *Lack of participation* is defined as the administrator did not participate in the professional learning community. (Table 5.2). For example, on the Exit Ticket Survey for PLC session 1, one respondent noted the assistant principal was "pretty quiet, [and] didn't have much to add" (Teacher respondent, personal communication, January 27, 2021). Further, from the field notes taken by the researcher, the school's administration did not attend one of the four (25%) PLC sessions and arrived late to PLC session 3. Through the descriptive coding process of the exit ticket survey data and the quantitative data gathered by the researcher's field notes, there were components of this intervention when the school's administration showed a *lack of participation.* In discussing the characteristics of an effective PLC, DuFour (2004) speaks about the significance of a supportive and shared leadership among those participating in the PLC. Administrator participation is imperative to show support for the teachers' work (Hoy and Sweetland, 2001) and the decision-making process (DuFour, 2004) about how to implement the strategies and activities discussed during the session.

Conclusions. The administration's level of engagement scores as rated by the teachers ranged from three to four. Further the mean level of engagement for the PLC sessions attended by the assistant principal was 3.67 ($M=3.67$, $SD=0.47$), on a scale from zero to five (zero indicating completely disengaged and five completely engaged). The quantitative data collected from the exit ticket survey and field notes reflect the qualitative data shared by the participants in the exit ticket surveys. The descriptive codes from the exit ticket survey revealed the theme of participation and indicated codes of *adding ideas, support, and lack of participation* (Table 5.2). As described by the participating teachers' the majority of the

(83.33%, n=5) assistant principal's engagement scores were rated a three or higher, however there was one session where a participant rated the assistant principal's engagement as a two out of five. Overall, the teachers described the assistant principal as being moderately engaged based on the exit ticket survey.

Research Question 3

RQ3: What was the level and quality of participant engagement in the mathematics PLCs and coaching cycles?

The third process research question explores the participants' level and quality of engagement in the mathematics PLC and coaching sessions. Field notes were taken on the number of times a participant talked during a PLC session, which were analyzed using descriptive statistics (Table 5.3). The exit ticket survey results on the quality of the participants' engagement were analyzed using descriptive statistics (Table 5.4) and both the exit ticket survey results and the focus group interview data were analyzed using descriptive coding. The descriptive codes were used to develop the overall theme of **engaging topics** from the data (Lochmiller & Lester, 2017) (Table 5.5).

Table 5.3 provides participants' level of their engagement in the mathematics PLC sessions. The researcher recorded each time a teacher talked during the PLC session in the field notes. The range of the participants' level of engagement in the mathematics PLCs varied from zero to three times per session. The mean level of engagement in the results orientation section of the PLC was M=0.88 times and the mean level of engagement in the collective learning section of the PLC was M=1 time. The mean level of engagement for the collective learning portion of the PLC was higher than the mean level of engagement for the results orientation section of the PLC. Specifically, the mean level of participant engagement for sessions one through four was M=2.5 (SD=0.5), M=3 (SD=0), M=0.5 (SD=0.5), and M=1.5 (SD=0.5) respectively. Overall, teachers participated in the PLC session M=1.88 times during the PLC intervention as determined by the number of times teachers talked and raised their hand during the sessions. Participant 1 engaged 1.75 times per mathematics PLC session and participant 2 engaged 2 times per mathematics PLC session. Compared to the mean level of participant engagement (M=1.88, SD=1.13), session 1 and 2 had higher levels of participant engagement, whereas sessions 3 and 4 had lower levels of participant engagement.

Table 5.3

Participants' Level of Engagement by PLC session

Session	Participant Number	Number of Times Participated in Results Orientation	Number of Times Participated in Collective Learning	Total Number of Times Participated in PLC Session
1	1	1	1	2
	2	1	2	3
2	1	1	2	3
	2	1	2	3
3	1	0	0	0
	2	1	0	1
4	1	1	1	2
	2	1	0	1

Furthermore, both participants shared how engaging the coaching sessions were during the focus group interview. When asked "Did you feel the professional development provided by the mathematics PLC and coaching sessions were relevant to your practice as a mathematics teacher? Why or why not?" one teacher shared:

> I definitely think our coaching sessions were the most helpful, um, out of everything… You and I focused on questioning a lot and making sure, you know, we were doing rigorous questioning, not just like, simple baseline questions…I feel like diving deeper one-on-one was really helpful…you were able to see the misconceptions, like, first-hand. So I think that really helped with planning and being effective in the classroom (Participant 2, Focus Group Interview).

Both participants agreed the individual attention spent planning upcoming lessons and focusing on higher level questioning during the coaching sessions was engaging and relevant to their practice.

Table 5.4 provides participant ratings of their engagement in the mathematics PLC and coaching sessions. The participants ranked their engagement on a scale from zero to five (zero meaning completely disengaged and five meaning completely engaged). Both participants (100%) rated their engagement a four or more on the Likert scale for all four sessions. Specifically, the mean engagement ratings for sessions 1 through 4 was a 4.5 (M=4.5, SD=0.5). This information reveals high levels of participant responsiveness in the PLC and coaching sessions as perceived by the teachers.

Table 5.4

Participant Self-Reported Level of Engagement

Session Number	0 (completely disengaged)	1	2	3	4	5 (completely engaged)
Session 1	0	0	0	0	1	1
Session 2	0	0	0	0	1	1

Session 3	0	0	0	0	1	1
Session 4	0	0	0	0	1	1

The participants were moderately engaged during the PLC sessions. This level of engagement was exemplified when the teachers participated in *planning for future instruction* and *strategies for student misconceptions.* These codes were captured by the theme, **engaging topics** (Table 5.5). The theme **engaging topics** refers to the types of topics participants were engaged in, though moderately, during the PLC sessions (Table 5.5).

Table 5.5

Codebook

Theme	Code	Definition	Example
Engaging topics	Planning for future instruction	Time during PLC sessions for planning upcoming mathematics lessons	"More about planning for future lessons" (Teacher respondent, personal communication, March 1, 2021)
	Strategies for student misconceptions	Strategies that can be implemented during instruction to prevent or correct student misconceptions in mathematics	"Continuing to talk about how it fix misconceptions" (Teacher respondent, personal communication, March 29, 2021)

Engaging topics. The theme, **engaging topics** refers to the types of topics participants were engaged in, though moderately, during the PLC sessions. During the three (75%, n=3) of the sessions, the code *planning for future instruction* was developed and defined as time during PLC and coaching sessions for planning upcoming mathematics lessons (Table 5.5). For example, on the exit ticket survey for session 1, one respondent requested wanting to plan for "more practice problems for students" (Teacher respondent, personal communication, January 27, 2021). Additionally, during the focus group interview one participant shared "focus[ing] on, like, what we're doing later helps us prepare for and plan for what's coming up, [it is] more engaging and more helpful" (Participant 1, Focus Group Interview). The qualitative data from the exit ticket survey shows the teachers were actively engaged (M=4.5, n=8) in all four sessions while planning for upcoming mathematics lessons, however the participants desired more time for this component of the research intervention.

In two (50%, n=2) out of the four sessions, a code of *strategies for student misconceptions* was developed through the descriptive coding process. The code of *strategies for student misconceptions* is defined as strategies that can be implemented during instruction to prevent or correct student misconceptions in mathematics (Table 5.5). For example, on the exit ticket survey for session 3, one respondent noted wanting to "continu[e] to talk about how to fix misconceptions" (Teacher respondent, personal communication, March 29, 2021). Additionally, during the focus group interview, one participant shared:

> I think looking back is helpful. I mean yes, looking forward is always important, but looking backwards…for flex days, being able to know, like, seeing the misconceptions and stuff like that...and then keeping that in the back of my mind for possibly next year, you know? Or in the future seeing, like, we know these are common misconceptions. We might as well try to get them from the get-go than wait til they happen and not have to go back and fix (Participant 2, Focus Group Interview).

The qualitative data from the exit ticket survey shows the teachers were actively engaged (M=4.5, SD=0.5) in the data discussion for all four sessions, however the participants desired more time in discussing *strategies for student misconceptions.*

Conclusions. Overall, participants raised their hand and talked approximately 2 times per mathematics PLC session and according to the participants, their mean level of engagement for the PLC sessions was a 1.88 (M=1.88, SD=1.13) and the participant ratings for their engagement in sessions 1 through 4 was a 4.5 (M=4.5, SD=0.5). Furthermore, the theme of **engaging topics** emerged from the data collected by the exit ticket survey and the focus group interview, including the descriptive codes *planning for future instruction* and *strategies for student misconceptions* (Table 5.5). The participants valued the time spent on analyzing student work samples, developing strategies to meet the students' needs, and planning for upcoming standards with a focus on questioning.

Research Question 4

RQ4: How did participating in mathematics PLCs and coaching cycles change teachers' pedagogical content knowledge?

To respond to the fourth research question, the teachers' pretest and post-test responses to the MKT instrument were analyzed using descriptive statistics. The data showed a variance in mathematics pedagogical content knowledge. The preassessment scores ranged from 9 (32.14%, n=2) to 13 (44.83%, n=2) correct responses out of either 28 or 29 questions on the number concepts and operations portion of the MKT instrument, depending on the form assigned (Table 5.6). The posttest scores ranged from nine (31.03%, n=2) to 17 (60.71%, n=2) correct responses out of either 28 or 29 questions on the number concepts and operations portion of the MKT instrument, depending on the form assigned (Table 5.6). Both participating teachers (n=2) had low MKT scores, however Participant 2 showed growth on the MKT posttest (Table 5.6). When analyzing each participant's difference between the MKT instrument pretest and posttest, participant 1's score declined slightly by -1.11% and participant 2's score increased by 15.88% (Table 5.6). The average difference for the participants was a 7.39 (SD=8.5) increase from pretest to posttest scores.

Table 5.6

MKT Scores

Participant	MKT Pretest Score	MKT Posttest Score	Difference between Pretest and Posttest Score
1	9/28	9/29	-1.11%
2	13/29	17/28	15.88%

The classroom observations in mathematics were analyzed using a priori coding. The a priori codes were used to develop the theme of questioning from the data (Lochmiller & Lester, 2017) (Table 5.7). Each participant was observed in session 1 and session 4 during the intervention research study. Although the MKT scores remained relatively low, the classroom observational data indicated an increase in teachers' pedagogical content knowledge when analyzing the data from the types of questions posed during mathematics instruction. Both teachers expressed participating in the PLC and coaching sessions has affected their pedagogical content knowledge by focusing on questioning to elicit higher levels of thinking from their students (Participant 1, Focus Group Interview; Participant 2, Focus Group

Interview). Participant 1 shared "questioning was huge…[and] definitely helpful" (Participant 1, Focus Group Interview) and Participant 2 stated "questioning…was really beneficial" (Participant 2, Focus Group Interview).

Table 5.7

Codebook

Theme	Code	Definition	Example
Questioning	Initiation-response-feedback (IRF)	"[T]he teacher asks a question, a student responds, and the teacher provides or evaluates the response" (McGatha, Bay-Williams, Kobett, & Wray, 2018, p. 95)	"How much is left over?" (Participant 2, Session 4 Classroom Observation)
	Funneling	"[T]he teacher leads students through a series of questions to the teacher's desired end" (McGatha et al., 2018, p. 95)	"How many ones do we need to subtract? Do we have enough? What do we need to decompose to get more ones?" (Participant 2, Session 4 Classroom Observation)
	Focusing	"[T]he teacher asks questions based on the students' thinking to support them in thinking at high levels" (McGatha et al., 2018, p. 95)	"How is a ruler similar to a number line?" (Participant 1, Session 4 Classroom Observation)

The data collected during the session 1 classroom observations revealed 63.33% of the questions posed by teachers elicited lower levels of critical thinking. This data reflects the research conducted by the Mid-continent Research for Education and Learning (2009). The Mid-continent Research for Education and Learning found sixty percent of questions posed by teachers were at the two lowest levels of Bloom's Taxonomy, knowledge/remembering and comprehension/understanding (Mid-continent Research for Education and Learning, 2009). Developing high-level questions can develop a deeper understanding of student content knowledge, but this level of questioning requires preplanning on the part of the teacher (McGatha et al., 2018). Planning for high level questioning is time consuming, however, it promotes students' abilities to apply, analyze, evaluate, and create (McGatha et al., 2018). After preplanning for high-level questions, such as focusing questions, there was a 34.76% decrease in the number of IRF questions posed by the teacher and a 25.96% increase in the number of focusing questions (Table 5.8).

Table 5.8

Prevalence of Questioning

Participant	Session 1 IRF	Session 4 IRF	Session 1 Funneling	Session 4 Funneling	Session 1 Focusing	Session 4 Focusing
1	53.84%	44.44%	23.08%	0%	23.08%	55.56%
2	70.59%	16.67%	23.53%	56.25%	0.06%	27.08%
Total	63.33%	28.57%	23.33%	32.14%	13.33%	39.29%

Questioning. The theme, **questioning**, refers to the different types of questions teachers used during mathematics instruction and includes the codes, *initiation-response feedback (IRF), funneling, and focusing questions.* The session 1 classroom observation data revealed that both (100%) of the participants observed posed questions called *initiation-response-feedback (IRF)* (Table 5.8). *IRF* are questions teachers ask that require a very low level of cognitive demand (McGatha et al., 2018). The student responds with an answer and the teachers assesses their answer with brief feedback (McGatha et al., 2018). For example, one teacher asked, “How much is left over?” (Participant 2, Session 1 Classroom Observation) and “What number would come after 55?” (Participant 1, Session 1 Classroom Observation). In this example, the response that teachers expected were one-word or brief responses.

The findings from the session 1 classroom observations also revealed both participants used *funneling* to scaffold their students responses to guide them toward the correct answer. In *funneling*, the teacher delivers a series of questions to lead students through the process of solving the problem (McGatha et al., 2018). In the following example, the process of questioning by the teacher illustrates how the teacher is funneling the students through a problem on subtracting two three-digit numbers:

> Teacher: Who can tell me how many ones we should put on our board?
>
> Teacher: How many tens are we going to need?
>
> Teacher: How many hundreds are we going to need?
>
> Teacher: How many ones can I subtract?
>
> Teacher: Do we have enough?
>
> Teacher: Who can tell me what we need to do?
>
> (Participant 2, Session 1 Classroom Observation)

This example illustrates the use of funneling to scaffold learning. The teacher begins with a broad question to elicit feedback from the students. If the students need more support, she then uses questioning to guide students through the step-by-step process of the mathematics problem.

In the session 1 classroom observations, a vast majority of the questions posed by teachers were IRF or funneling questions. During session 1, 86.67% (n = 26) out of 30 questions posed by the teachers were IRF of funneling questions. Only four (13.33%) of the questions posed by the participants were focusing questions. *Focusing* questions place more emphasis on student thinking to support the higher levels of cognitive demand (McGatha et al., 2018). Focusing questions are based on the students' work to support them to think at higher levels (McGatha et al., 2018). For example, a teacher posed a focusing question during a lesson on measurement. She asked, "How is a ruler similar to a number line?" (Participant 1, Session 4 Classroom Observation). In this example the teacher elicits a deeper level of student thinking to reach a higher level of cognitive demand by asking the students to make connections between a ruler and a number line.

Conclusions. Although the qualitative data gathered by focus group interview revealed that participants found strategies for student misconceptions (Participant 1, Focus Group Interview) and using the data share out to plan for differentiation (Participant 2, Focus Group Interview) to be valuable, the participants overwhelmingly shared the focus on questioning was the most beneficial aspect of the PLC and coaching sessions (Participant 1, Focus Group Interview; Participant 2, Focus Group Interview). The quantitative data collected from the classroom observations in sessions 1 and 4 showed a 25.96% increase in the number of focusing questions posed by the participating teachers (Table 5.9). While the participants' MKT scores remained low for the duration of the study, the classroom observations and focus group interview showed improvement. Participant 2 shared:

> I know I keep coming back to the questioning, but I think for me that was, like, seriously the most effective. And seeing as a teacher how certain questioning will be able to help the students further understand the concept…And I think that helped me grow as a teacher 'cause I can say, like, ask more of those questions and look at the content and see, you know, where can I ask those questions (Participant 2, Focus Group Interview).

The results of the focus group interview data supported the quantitative data collected during the classroom observations. Both strands of data showed an increase in participants' pedagogical content knowledge through focusing on questioning during PLC and coaching sessions.

Research Question 5

RQ5: How did teachers' sense of self-efficacy change after participating in mathematics PLCs and coaching sessions?

a. **How did teachers' mathematics teaching efficacy beliefs change after participating in mathematics PLCs and coaching sessions?**

To examine teaching efficacy and specifically mathematics teaching efficacy beliefs, the teachers' pretest and posttest responses to the Teacher Efficacy Scale and MTEBI were analyzed using descriptive statistics. The Teacher Efficacy Scale pretest had a mean score of 4.84 (SD=1.02) and the posttest had a mean score of 4.86 (SD=0.95). The difference between the means from the Teacher Efficacy pretest and posttest score was 0.02. The MTEBI pretest had a mean score of 4.37 (SD=1.3) and the posttest had a mean score of 4.8 (SD=0.94). The difference between the means from the Teacher Efficacy pretest and posttest score was 0.43.

These findings reveal a slight increase from the pretest to posttest mean scores, in both teaching efficacy and mathematics teaching efficacy beliefs. The qualitative data collected from the focus group interview revealed a theme of **confidence** through the descriptive coding process (Table 5.9). The descriptive codes developed from the focus group interview describe the areas participants demonstrated confidence, which included *different perspectives, and multiple strategies* (Table 5.9).

Table 5.9

Codebook

Theme	Code	Definition	Example
Confidence	Different perspectives	The ability to view how to effectively teach the mathematics content through different student perspectives.	"I mean basically just letting me see it through other people's eyes. Um, you know, and understanding that math doesn't come easy for everybody." (Participant 1, Focus Group Interview)
	Multiple strategies	The ability to implement various strategies to best meet the needs of the students.	"Using all these different strategies, too, I know also made me realize that like, kids really do pick different strategies" (Participant 2, Focus Group Interview)

Confidence. The theme, **confidence**, refers to the teachers' level of self-efficacy in teaching mathematics. From the data collected on the Teacher Efficacy Scale pretest, one participant (50%) strongly disagreed, and one participant (50%) disagreed slightly more than agreed when given the choice, they would not invite the principal to evaluate their math teaching. However, on the Teacher Efficacy Scale posttest, both participants (100%) responded they strongly agreed they would invite the principal to evaluate their math teaching, when given the choice. From the data collected on the MTEBI posttest, both participants (100%) strongly agreed if the principal suggested that they change some of the class curriculum, they would feel confident in their skills to implement the unfamiliar curriculum. This change in response displays the confidence the teachers have in their math teaching. As supported by the focus group interview data, Participant 2 shared:

> I feel a lot stronger than I have before…I struggled a lot in math. So, um, I haven't always been confident in my teaching, but after this I definitely do feel a lot more confident. I wouldn't say, like, I'm an expert or something like that, but I definitely feel like this has boost a lot of my confidence in teaching math (Participant 2, Focus Group Interview).

Through participating in the mathematics PLCs and coaching sessions, Participant 2 is expressing an increase in her efficacy in teaching mathematics. Finally, on the Teacher Efficacy Scale posttest, both participants (100%) strongly disagreed they generally teach math ineffectively.

Different perspectives. The code *different perspectives* was developed and defined as the ability to view how to effectively teach the mathematics content through different student perspectives. (Table 5.9). From the data collected on the Teacher Efficacy Scale pretest, one participant (50%) agreed slightly more than disagreed and one participant (50%) disagreed slightly more than agreed when given the choice, when a student has difficulty understanding a math concept, they are usually at a loss as to how to help the student understand it better. However, on the Teacher Efficacy Scale posttest, both participants (100%) moderately disagreed they are usually at a loss as to how to help the student understand it a math concept better. Furthermore, from the data collected on the MTEBI pretest, one participant (50%) disagreed slightly more than agreed and one participant (50%) agreed slightly more than disagreed when a student is having difficulty with an assignment, they are usually able to adjust it to his/her level. However, on the MTEBI posttest, one participant (50%) moderately agreed, and one participant (50%) strongly agreed they are able to adjust an assignment to their student's level when they are having difficulty with an assignment. This change in response from both participants (100%) shows how that they are better able to meet their students' needs through *different perspectives.* As supported by the focus group interview data, Participant 1 shared:

> I feel pretty confident in teaching mathematics. The one thing I struggle with when it comes to, like, teaching math is that math always came really easy to me. So sometimes it's hard for me to, like, take a step back and be like, okay. Why aren't you getting this?... So I think the meetings, the PLCs, like- they help me kinda look at it from someone else's eyes (Participant 1, Focus Group Interview).

Furthermore, Participant 2 discussed how "understanding…math doesn't come easy for everybody" (Participant 2, Focus Group Interview). Through participating in the mathematics PLCs and coaching sessions, both participants are expressing an increase in her efficacy in teaching mathematics from *different perspectives* to best meet the needs of their students.

Multiple strategies. The code *multiple strategies* was developed and defined as the ability to implement various strategies to best meet the needs of the students. (Table 5.9). From the data collected on the Teacher Efficacy Scale pretest, both participants (100%)

moderately agree the teacher is generally responsible for the achievement of students in math (M=5, SD=0). However, on the Teacher Efficacy Scale posttest, one of the participants (50%) responded they strongly agree with this statement. Additionally, from the data collected on the MTEBI pretest, one participant (50%) strongly agreed, and one participant (50%) strongly disagreed teachers are not a very powerful influence on student achievement when all factors are considered (M=3.5, SD=3.54). However, from the data collected on the MTEBI posttest, both participants (100%) strongly disagreed teachers are not a very powerful influence on student achievement when all factors are considered (M=6, SD=0). This change in response by one of the participants displays an increase in taking responsibility for students' mathematics achievement. This is further supported by the overall change in mean score from the pretest and posttest data collected by the MTEBI for this item. The difference in mean from the pretest to the posttest was a 2.5 increase. As supported by the focus group interview data, Participant 2 shared:

> They've really helped me like, open my eyes to see things from different angles, different, um, different perspectives. And, um, using all these different strategies, too, I know also made me realize that like, kids really do pick different strategies (Participant 2, Focus Group Interview).

Through participating in the mathematics PLCs and coaching sessions, Participant 2 is expressing an increase in her efficacy in teaching mathematics by building a repertoire of *multiple strategies.* With the increase in taking responsibility for students' mathematics achievement, the participants have taken the initiative to learn about and include multiple strategies in teaching the mathematics content standards. In support of this data, on the

Teacher Efficacy Scale pretest, one participant moderately disagreed (50%) and one participant (50%) strongly disagreed they generally teach math ineffectively (M=5.5, SD=0.5). On the Teacher Efficacy Scale posttest, both participants (100%) strongly disagreed they generally teach math ineffectively (M=6, SD=0). There is an average difference from the pretest to the posttest score of 0.5. This data shows the confidence the teachers have in their ability to teach mathematics effectively to their students.

Conclusions. Based on the data collected from the Teacher Efficacy Scale, MTEBI, and the focus group interview, teachers' sense of self-efficacy increased after participating in the mathematics PLCs and coaching sessions. During the focus group interview, Participant 1 shared:

> [R]ather than just using like, um, the place value box every time, which makes sense to me, but some of them really like the number line. It helps them. So, um, or the chart, 120 chart. So I would say, just, it's made me a stronger teacher and a more understanding teacher. Um, and being able to see if from other people's point of view (Participant 1, Focus Group Interview).

In this response, Participant 1 is expressing how her teacher efficacy has increased by meeting her students' needs through *different perspectives* and *multiple strategies* learned in the mathematics PLC and coaching sessions.

Implications for Practice

Despite the best efforts of the No Child Left Behind Act of 2001, students who receive free or reduced meal prices underperform compared to their more affluent peers on standardized mathematics assessments (Gamoran & Long, 2006; Morgan et al., 2016).

Although limited in sample size and scope, this study revealed meaningful results that can be replicated by schools with the responsibility of providing professional development for elementary mathematics teachers. With slight increases in the quantitative scores from the MKT, Teachers Efficacy Scale, and MTEBI, paired with the qualitative data collected from the exit ticket surveys, field notes, and focus group interview data, this study suggests schools should invest in teachers' pedagogical content knowledge and sense of self-efficacy in teaching mathematics because it informs their teaching, which consequently supports student outcomes (Campbell & Malkus, 2011; Biancarosa & Bryk, 2011; Gee & Whaley, 2016; Powell & Diamond, 2011).

There are practical implications about the process of this study if a researcher or school wanted to implement this work in a similar context. The structure of the mathematics PLCs and coaching sessions should follow the characteristics of a supportive and shared leadership (DuFour, 2004); a shared vision (DuFour, 2004; Gee & Whaley, 2016); collective learning (Desimone et al., 2002; DuFour, 2004; Gee & Whaley, 2016); a sensitive and encouraging learning environment (DuFour, 2004; Gee & Whaley, 2016); shared practice (DuFour, 2004; Gee & Whaley, 2016); and a results orientation (Desimone et al., 2002; DuFour, 2004). Specifically, this study showed the importance of supportive leadership, the school's administration. Although the principal was not able to attend any portion of the study implementation and the assistant principal attended just two full and one half of the PLC sessions, support from the administration was imperative for practical implementation of the strategies and activities discussed during the sessions. These characteristics are imperative because they likely supported teachers' increase in pedagogical content knowledge (Desimone et al., 2002; Gee &

Whaley, 2016) and sense of self-efficacy in teaching mathematics (Hord, 1997; Weißenrieder et al., 2015).

Since the intervention adhered to the theoretical guidelines outlined in the literature, the researcher expected the intervention to produce the outcomes in the logic model (Appendix D). However, after implementation, there was a nuance the researcher would like to note. After reviewing the logic model, the short-term goal of the intervention was to increase teachers' pedagogical content knowledge in mathematics, which would consequently lead to the intermediate goal of increasing teachers' sense of self-efficacy in mathematics. However, after the implementation of the intervention, Participant 1 showed a decrease of 1.11% in their MKT score (which measures pedagogical content knowledge), yet an increase in their Teacher Efficacy Scale and MTEBI (which measures mathematics teaching efficacy beliefs) scores. This data suggests the outcomes produced by the intervention could be more complex than outlined in the original theory of treatment and logic model developed by the researcher.

The teachers not only worked on building their pedagogical content knowledge in mathematics through learning about the strategies and activities from these sessions, but the teachers also worked their confidence in implementing these strategies from the PLC and coaching sessions. Especially with the virtual learning schedule, the participants and the researcher did express a need for more time for coaching and to implement the PLC sessions with fidelity. For example, during the PLC sessions, the teachers were expected to come with data and student work samples to share with the PLC members. This explains why the participants mostly had a one for participation (raising their hand and talking) for results orientation. As the PLC moved to discussing the upcoming standard and sharing strategies and activities (collective learning), this is where the researcher would have liked the participants to raise their hand and talk more. However, collective learning was during the second half of the PLC session, and there always seemed to be a need for more time. To allow for more time, school administrators should consider designating time in the schedule to implement PLC and coaching sessions to provide teachers with the appropriate job-embedded professional development. Effective learning opportunities sustained over time are necessary to build teachers' pedagogical content knowledge and sense of self-efficacy in teaching mathematics.

Limitations

There are two limitations for this research study. First, the research study was only implemented for four months. After conducting the literature review of possible interventions to increase teachers' pedagogical content knowledge and sense of self-efficacy in teaching mathematics, the majority of the empirical studies were implemented for at least two years to show an influence on teachers' pedagogical content knowledge and sense of self efficacy (Yopp et al., 2017). Second, the convenience sample only included two participants. This small sample causes some limitations for the study design and the data analysis. There is a threat to external validity and generalizability because it would be difficult to generalize the results from this study to a broader population with a small number of participants (Lochmiller & Lester, 2017; Shaddish et al., 2002). Additionally, the researcher could not use inferential statistics to make inferences about the broader population because of the small sample size (Shaddish et al., 2002). Further, with a limited number of participants there was not a control group to compare a similar population that will not receive the treatment, in this case the research intervention, to a population that did receive the treatment to measure the effects of the program on teachers' pedagogical content knowledge and sense of self-efficacy.

Although the study had a small sample size, the role of mixed methods research is an advantage to the limitations discussed. The various quantitative and qualitative strands of data allowed the researcher to fulfill the requirements of the process and outcome evaluation beyond what quantitative or qualitative methods would be capable of separately (Creswell & Plano-Clark, 2018). Furthermore, the combination of quantitative and qualitative methods provided the researcher with multiple data sources to better support the findings and arguments for each research question (Creswell & Plano-Clark). Although the sample size is a limitation, there is still valuable information to be gleaned from the implementation of this research study.

Future Research

This research study examined two elementary mathematics teachers who participated in four professional learning community and 12 coaching sessions. While the participants did not demonstrate major changes in their pedagogical content knowledge and sense of self-efficacy from the pre- and post-intervention scores, qualitative evidence suggests that participation in PLC and coaching sessions support teachers' pedagogical content knowledge and sense of self-efficacy. Further research is needed to determine the most effective approach for implementing this intervention to elementary mathematics teachers. The research suggests increasing the time allotted for the program, specifically the implementation of the PLC sessions. Future researcher is needed to discover if more time will increase participant engagement in the collective learning aspect of the intervention. Developing relevant and efficient professional development opportunities involving on-going coaching support and feedback will help elementary mathematics teachers advance their pedagogical content knowledge and confidence to close the gap more effectively in achievement between students who receive free or reduced meal prices compared to their more affluent peers.

Since this study was only implemented over the course of four months, a longer time frame is suggested to evaluate the effect of this program on teachers' pedagogical content knowledge and sense of self-efficacy in teaching mathematics. Considering the small sample size for the study, the researcher recommends the replication of this program with a larger sample size and possibly scaling the intervention up, particularly since the intention of this study was to recruit first and second grade teachers. Finally, to examine the long-term outcomes of this intervention, the research suggests including future research on student outcomes. This research should include student observations and standardized mathematics assessment scores to evaluate the influence of the program on students' mathematics achievement.

Conclusions

Elementary school students who receive free or reduced meal prices underperform compared to their more affluent peers on standardized mathematics assessments (Gamoran & Long, 2006; Morgan, Farkas, Hillemeier, & Maczuga, 2016). Although the purpose of the No Child Left Behind Act of 2001 was to close the achievement gap between disadvantaged students and their peers by the 2013-2014 school year, these gaps persist (Mehta, 2013). This research study examined two second grade teachers' experience in participating in a PLC and coaching program, which was designed to influence teachers' pedagogical content knowledge and sense of self-efficacy in teaching mathematics. These factors were in the researcher's sphere of control and have the power to influence student outcomes (Campbell & Malkus, 2011; Biancarosa & Bryk, 2011; Gee & Whaley, 2016; Powell & Diamond, 2011). Although there were only slight differences from the quantitative pretest to the posttest scores, qualitative data suggests participation in a PLC and coaching program supports teachers' pedagogical content knowledge and sense of self-efficacy. As this research study and the literature indicate, teachers desire more time to support their pedagogical content knowledge and sense of self-efficacy in teaching mathematics. It is imperative for schools to dedicate job-embedded professional development programs to meet the needs of their teachers to influence student outcomes and to close the achievement gap in mathematics.

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Appendix A

Sample MKT Instrument Items

1. Mr. Allen found himself a bit confused one morning as he prepared to teach. Realizing that ten to the second power equals one hundred ($10^2 = 100$), he puzzled about what power of 10 equals 1. He asked Ms. Berry, next door. What should she tell him? (Mark (X) ONE answer.)

a) 0

b) 1

c) Ten cannot be raised to any power such that ten to that power equals 1.

d) −1

e) I'm not sure.

2. Imagine that you are working with your class on multiplying large numbers. Among your students' papers, you notice that some have displayed their work in the following ways:

Student A	*Student B*	*Student C*
$\begin{array}{r} 35 \\ \times 25 \\ \hline 125 \\ +75 \\ \hline 875 \end{array}$	$\begin{array}{r} 35 \\ \times 25 \\ \hline 175 \\ +700 \\ \hline 875 \end{array}$	$\begin{array}{r} 35 \\ \times 25 \\ \hline 25 \\ 150 \\ 100 \\ +600 \\ \hline 875 \end{array}$

Which of these students would you judge to be using a method that could be used to multiply any two whole numbers?

	Method would work for all whole numbers	Method would NOT work for all whole numbers	I'm not sure
a) Method A	1	2	3
b) Method B	1	2	3
c) Method C	1	2	3

3. Mr. Fitzgerald has been helping his students learn how to compare decimals. He is trying to devise an assignment that shows him whether his students know how to correctly put a list of decimals in order of size. Which of the following sets of numbers will best suit that purpose?

a)	.5	7	.01	11.4
b)	.60	2.53	3.14	.45
c)	.6	4.25	.565	2.5

d) Any of these would work well for this purpose. They all require the students to read and interpret decimals.

4. Mrs. Jackson is getting ready for the state assessment, and is planning mini-lessons for students focused on particular difficulties that they are having with adding columns of numbers. To target her instruction more effectively, she wants to work with groups of students who are making the same kind of error, so she looks at a recent quiz to see what they tend to do. She sees the following three student mistakes:

$$\text{I)}\quad \begin{array}{r} 1 \\ 38 \\ 49 \\ +65 \\ \hline 142 \end{array} \qquad \text{II)}\quad \begin{array}{r} 1 \\ 45 \\ 37 \\ +29 \\ \hline 101 \end{array} \qquad \text{III)}\quad \begin{array}{r} 1 \\ 32 \\ 14 \\ +19 \\ \hline 64 \end{array}$$

Which have the same kind of error? (Mark ONE answer.)

a) I and II
b) I and III
c) II and III
d) I, II, and III

Appendix B

Teacher Efficacy Scale

Directions: Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate numeral to the right of each statement.

Questions	Strongly disagree	Moderately disagree	Disagree slightly more than agree	Agree slightly more than disagree	Moderately agree	Strongly agree
1. When a student does better than usual, many times it is because I exerted a little extra effort.	1	2	3	4	5	6
2. The hours in my class have little influence on students compared to the influence of their home environment.	1	2	3	4	5	6
3. If parents comment to me that their child behaves much better at school than he/she does at home, it would probably be because I have some specific techniques of managing his/her behavior which they may lack.	1	2	3	4	5	6
4. The amount that a student can learn is primarily related to family background.	1	2	3	4	5	6
5. If a teacher has adequate skills and motivation, she/he can get through to the most difficult students.	1	2	3	4	5	6
6. If students aren't disciplined at home, they aren't likely to accept any discipline.	1	2	3	4	5	6
7. I have enough training to deal with almost any learning problem.	1	2	3	4	5	6
8. My teacher training program and/or experience has given me the necessary skills to be an effective teacher.	1	2	3	4	5	6
9. Many teachers are stymied in their attempts to help students by lack of support from the community.	1	2	3	4	5	6

10. Some students need to be placed in slower groups so they are not subjected to unrealistic expectations.	1	2	3	4	5	6
11. Individual differences among teachers account for the wide variations in student achievement.	1	2	3	4	5	6
12. When a student is having difficulty with an assignment, I am usually able to adjust it to his/her level.	1	2	3	4	5	6
13. If one of my new students cannot remain on task for a particular assignment, there is little that I could do to increase his/her attention until he/she is ready.	1	2	3	4	5	6
14. When a student gets a better grade than he usually gets, it is usually because I found better ways of teaching that student.	1	2	3	4	5	6
15. When I really try, I can get through to most difficult students.	1	2	3	4	5	6
16. A teacher is very limited in what he/she can achieve because a student's home environment is a large influence on his/her achievement.	1	2	3	4	5	6
17. Teachers are not a very powerful influence on student achievement when all factors are considered.	1	2	3	4	5	6
18. If students are particularly disruptive one day, I ask myself what I have been doing differently.	1	2	3	4	5	6
19. When the grades of my students improve it is usually because I found more effective teaching approaches.	1	2	3	4	5	6
20. If my principal suggested that I change some of my class curriculum, I would feel confident that I have the necessary skills to implement the unfamiliar curriculum.	1	2	3	4	5	6
21. If a student masters a new math concept quickly, this might be because I	1	2	3	4	5	6

knew the necessary steps in teaching that concept.						
22. Parent conferences can help a teacher judge how much to expect from a student by giving the teacher an idea of the parents' values toward education, discipline, etc.	1	2	3	4	5	6
23. If parents would do more with their children, I could do more.	1	2	3	4	5	6
24. If a student did not remember information I gave in a previous lesson, I would know how to increase his/her retention in the next lesson.	1	2	3	4	5	6
25. If a student in my class becomes disruptive and noisy, I feel assured that I know some techniques to redirect him quickly.	1	2	3	4	5	6
26. School rules and policies hinder my doing the job I was hired to do.	1	2	3	4	5	6
27. The influences of a student's home experiences can be overcome by good teaching.	1	2	3	4	5	6
28. When a child progresses after being placed in a slower group, it is usually because the teacher has had a chance to give him/her extra attention.	1	2	3	4	5	6
29. If one of my students couldn't do a class assignment, I could be able to accurately assess whether the assignment was at the correct level of difficulty.	1	2	3	4	5	6
30. Even a teacher with good teaching abilities may not reach many students.	1	2	3	4	5	6

Please select the most appropriate choice(s).

31. Which grade level do you currently teach?	Pre-K	K	1	2	3	4	5
32. Check any other grade levels you have taught at the elementary school level.	Pre-K	K	1	2	3	4	5

33. Record the years of experience you have teaching each of the checked grade levels.	Pre-K	K	1	2	3	4	5

34. Have you taught any other grade levels outside of the elementary school setting? If so, what content area and how many years of experience do you have teaching that content area?

____

____

____

35. The FARMs rate within my classroom is	Less than 10%	10%-20%	20%-30%	30%-40%	40%-50%	50%-60%	60%-70%	70%-80%	80%-90%	90%-100%
36. How many years of teaching experience do you have?	First year	Second year	Third year	4-5 years	6-7 years	8-10 years	11-15 years	16-20 years	21-25 years	26+ years

Appendix C

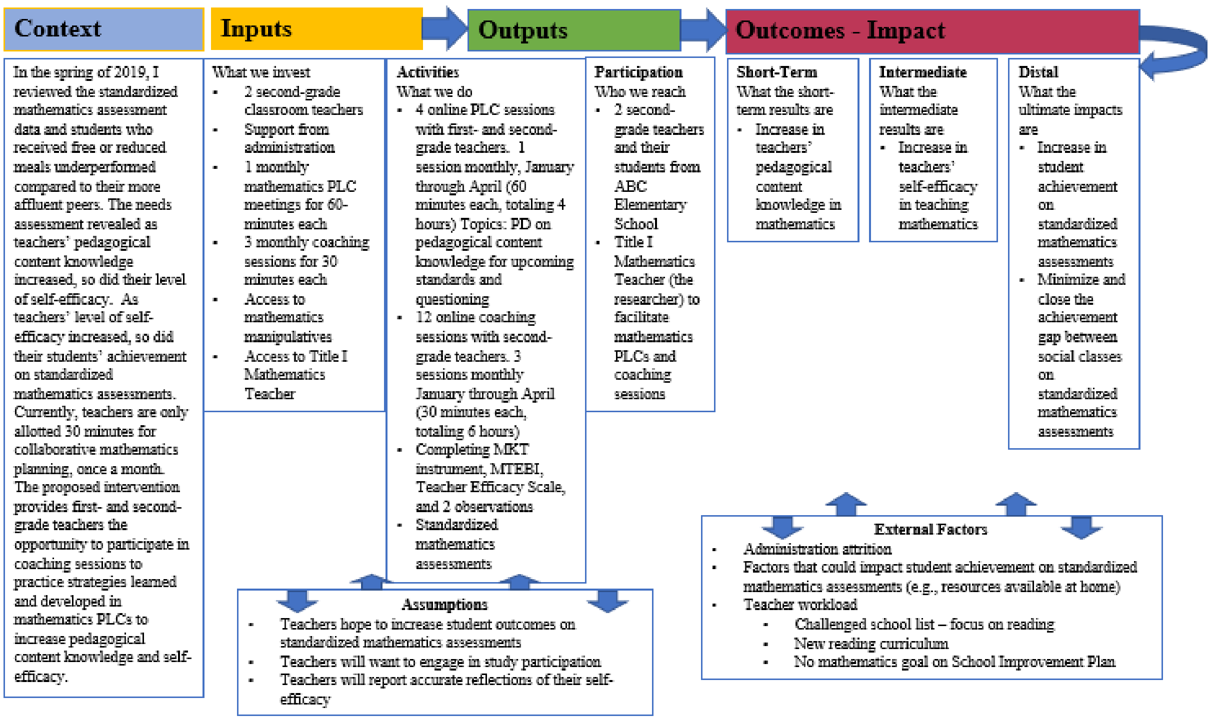
Observational Protocol

Teacher Questions	Types of Questioning
	○ IRF ○ Funneling ○ Focusing
	○ IRF ○ Funneling ○ Focusing
	○ IRF ○ Funneling ○ Focusing
	○ IRF ○ Funneling ○ Focusing
	○ IRF ○ Funneling ○ Focusing
	○ IRF ○ Funneling ○ Focusing

Adapted from Bay-Williams, J., McGatha, M., Kobett, B., and Wray, J. (2014). Mathematics Coaching: Resources and Tools for Coaches and Leaders, K-12. New York: Pearson Education, Inc.

Appendix D

Logic Model



Appendix E

Math Teaching Efficacy Beliefs Instrument

Directions: Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate numeral to the right of each statement.

Questions	Strongly disagree	Moderately disagree	Disagree slightly more than agree	Agree slightly more than disagree	Moderately agree	Strongly agree
1. When a student does better than usual in math, it is often because the teacher exerted a little extra effort.	1	2	3	4	5	6
2. I am continually finding better ways to teach math.	1	2	3	4	5	6
3. Even when I try very hard, I don't teach math as well as I do most subjects.	1	2	3	4	5	6
4. When the math grades of students improve, it is most often due to their teacher having found a more effective teaching approach.	1	2	3	4	5	6
5. I know the steps necessary to teach math concepts effectively.	1	2	3	4	5	6
6. I am not very effective in monitoring math achievement through hands-on activities.	1	2	3	4	5	6
7. If students are underachieving in math, it is most likely due to ineffective math teaching.	1	2	3	4	5	6
8. I generally teach math ineffectively.	1	2	3	4	5	6
9. The inadequacy of a student's math background can be overcome by good teaching.	1	2	3	4	5	6

10. The low math achievement of some students cannot generally be blamed on their teachers.	1	2	3	4	5	6
11. When a low-achieving child progresses in math, it is usually due to extra attention given by the teacher.	1	2	3	4	5	6
12. I understand math concepts well enough to be effective in teaching elementary math.	1	2	3	4	5	6
13. Increased effort in math teaching produces little change in some students' math achievement.	1	2	3	4	5	6
14. The teacher is generally responsible for the achievement of students in math.	1	2	3	4	5	6
15. Students' achievement in math is directly related to their teacher's effectiveness in math teaching.	1	2	3	4	5	6
16. If parents comment that their child is showing more interest in math at school, it is probably due to the performance of the child's teacher.	1	2	3	4	5	6
17. I find it difficult to explain to students why and how mathematics works.	1	2	3	4	5	6
18. I am typically able to answer students' math questions.	1	2	3	4	5	6
19. I wonder if I have the necessary skills to teach math.	1	2	3	4	5	6
20. Effectiveness in math teaching has little influence on the achievement of students with low motivation.	1	2	3	4	5	6
21. Given a choice, I would not invite the principal to evaluate my math teaching.	1	2	3	4	5	6
22. When a student has difficulty understanding a math concept, I am usually at a loss as to how to help the student understand it better.	1	2	3	4	5	6
23. When teaching math, I usually welcome student questions.	1	2	3	4	5	6

24. I know what to do to turn students on to math.	1	2	3	4	5	6
25. Even teachers with good math teaching abilities cannot help some kids learn math.	1	2	3	4	5	6

Appendix F

Exit Ticket Survey

Exit Ticket Survey

* 1. What is your participant number?

2. What is today's session number?

- ○ 1
- ○ 2
- ○ 3
- ○ 4

* 3. Did we meet the goals for this session?

- ○ Yes
- ○ No
- ○ Other (please specify)

* 4. On a scale from 0 to 5 (0 meaning completely disengaged and 5 meaning completely engaged), how engaged were you during this session?

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4

* 5. How could I improve future mathematics PLC and/or coaching sessions to support your professional learning?

* 6. How did the administrators attendance support the professional development?

* 7. On a scale from 0 to 5 (0 meaning completely disengaged and 5 meaning completely engaged), how engaged were the administrator(s) during this session?

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ Not applicable because there was not an administrator present for this session

Done

Appendix G

Focus Group Protocol

Date and Time: ____

Participants Present: ____

Interviewer: Rebecca Barnes

Introduction: *Hello and thank you for participating in this focus group interview. I appreciate your participation in my research study and I look forward to hearing responses to the interview questions. I will be asking questions about your experiences in the mathematics professional learning communities and coaching sessions, the change in your pedagogical content knowledge and self-efficacy in teaching mathematics. Please feel free to ask me any questions throughout the interview process. Do you have any questions before we begin?*

Questions:

Teacher Experiences in the PLC and Coaching Sessions (Process Evaluation)

1. What were some engaging activities you participated in during the mathematics PLC and coaching sessions? Why do you feel these activities were engaging? What activities were less engaging and why?
2. Did you feel the professional development provided by the mathematics PLC and coaching sessions were relevant to your practice as a mathematics teacher? Why or why not?
3. Which activities of the mathematics PLC and/or coaching sessions were most relevant to your work as a mathematics teacher?

Pedagogical Content Knowledge (Outcome Evaluation)

1. How did participation in the mathematics PLCs and coaching sessions affect your pedagogical content knowledge?

2. What strategies learned during the mathematics PLC and coaching sessions were most effective in your classroom?
3. What strategies learning during the mathematics PLC and coaching sessions were least effective in your classroom?

Teacher Self-Efficacy (Outcome Evaluation)

1. How confident do you feel in your ability to effectively teach mathematics to your students?
2. How has your participation in the mathematics PLC and coaching sessions influenced your ability to meet the needs of your students during mathematics instruction?

Conclusion: *Thank you for participating in this focus group interview and in my research study. I appreciate the time you dedicated to the study.*

Appendix H

Field Notes: Adherence

First Grade Sessions

Planned Program Implementation		Actual Program Implementation		Notes
Session & Date	Standard/Strategy	Session & Date	Standard/Strategy	Deviation from Plan
Pre-session: January 11, 2021	Pretest administration			
Session 1: January 27, 2021	Addition and subtraction within ten fluently and within 20/Number path, commutative property, and connecting addition to subtraction			
Session 2: February 24, 2021	Addition within 100 and subtracting multiples of ten/Using 120 chart			
Session 3: March 23, 2021	Compare two-digit numbers and addition within 100/Using base ten blocks			
Session 4: April 21, 2021	Addition within 100 (addition of a two-digit number and a one-digit number)/Numberless word problems			
Post-session: April 30, 2021	Posttest administration and focus group			

Second Grade Sessions

Planned Program Implementation		Actual Program Implementation		Notes
Session & Date	Standard/Strategy	Session & Date	Standard/Strategy	Deviation from Plan
Pre-session: January 11, 2021	Pretest administration			
Session 1: January 13, 2021	Addition and subtraction within 20 fluently and within 100/Decomposition, open number line, and regrouping			
Session 2: February 10, 2021	Place value, ten or 100 more, ten or 100 less than any number between 100-900/Using base ten blocks			
Session 3: March 9, 2021	Ordering numbers and skip counting by 5's/Using 120 chart			
Session 4: April 7, 2021	Addition and subtraction within 20 fluently, name and value of money/Using coins and a number line			
Post-session: April 30, 2021	Posttest administration and focus group			

Appendix I

Field Notes: Participant Responsiveness

Session	Participant Number	PLC Attendance	Coaching Attendance	Participation Tally
Pre-session	Administrator			
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
1	Administrator			
	1			

	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
2	Administrator			
	1			
	2			
	3			
	4			
	5			

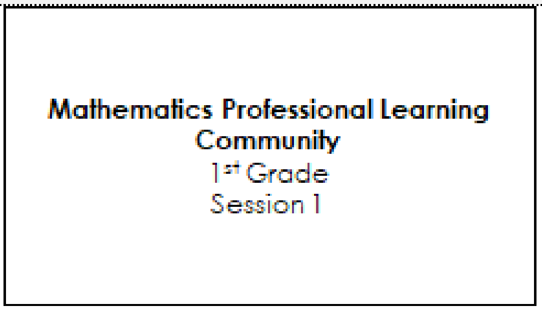
	6			
	7			
	8			
	9			
3	Administrator			
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			

4	Administrator			
	1			
	2			
	3			
	4			
	5			
	6			
	7			
	8			
	9			
Post-session	Administrator			
	1			
	2			
	3			

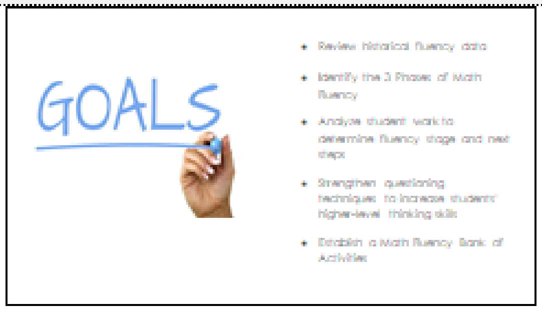
	4			
	5			
	6			
	7			
	8			
	9			

Appendix J

Sample Session Presentation



1



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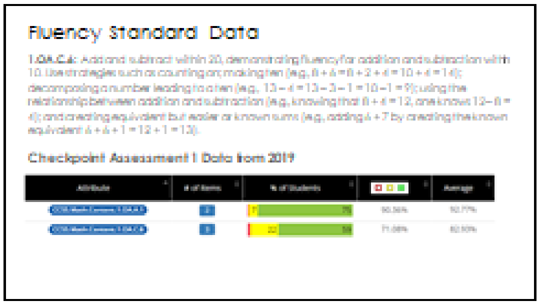

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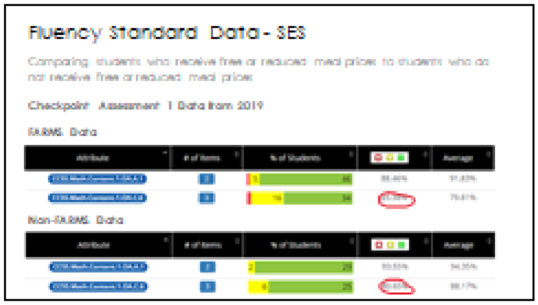

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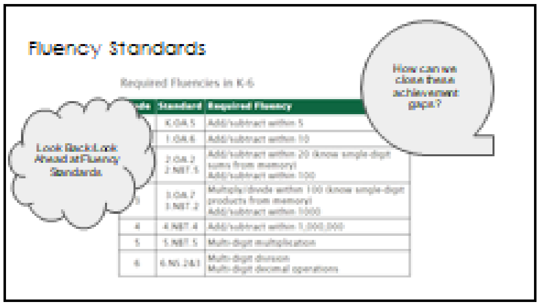
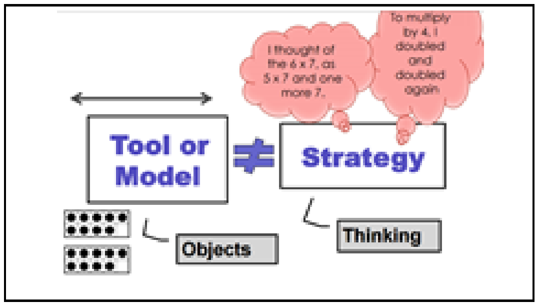




Number Sense Routines – Emphasis on Strategy

- **Look Quick:** Students determine what is represented by the ten frame to develop their subitizing. Students should focus on identifying the amount represented by using their part-part-whole understanding.
- **Ten Frame:** If students require an extension reveal the question on the slide and ask, "How the number would change if they added 1 or 2 to the ten frame". Provide time for students to work collaboratively and share out their strategies.

Questioning

Cannot stress enough how important questioning techniques are during Number Sense Routines

- Reasoning
- Justification
- Comparing and contrasting strategies

7

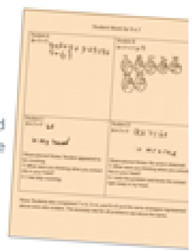
Phases of Fluency

Phase 1 Counting	Phase 2 Deriving	Phase 3 Mastery
Student uses counting strategies to solve. The student counts or counts on with objects or mentally.	Student uses reasoning strategies to solve. The student uses strategies based on known facts to solve for a given problem.	Student knows the fact from memory or uses a procedure efficiently and accurately to solve for an answer.

8

Student Work 9 x 7

- Discuss each student's thinking/strategy.
- What questions would you want to ask these students to learn more about their thinking?
- What evidence of the phases do you see?



9

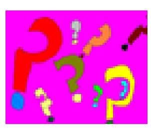
Based on the student work that you have analyzed, what would your next steps with students be and why?

10

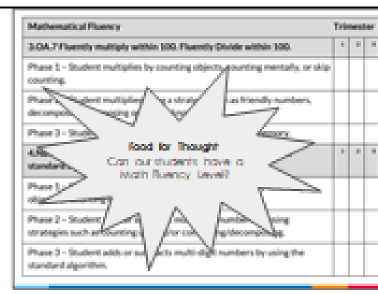
Questioning Techniques

- Initiate-Response-Feedback (IRF)
- Funneling
- Focusing

(McGatha, Bay-Williams, Kobett, & Wray, 2018)

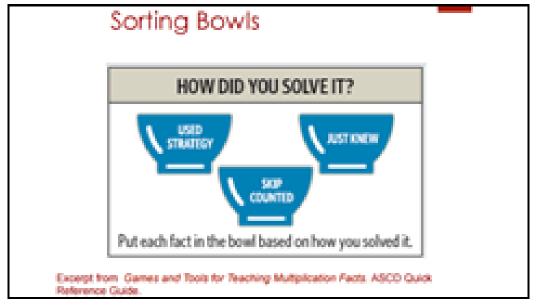


Let's develop focusing questions for fluency!

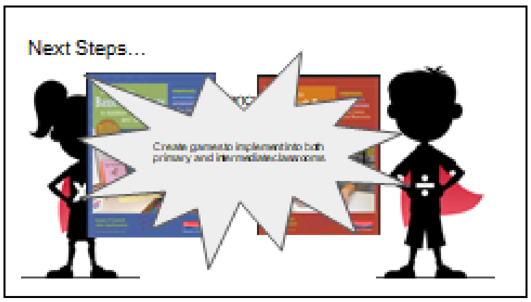



SHARE
Let's share activities to promote fluency practice!

13


Sorting Bowls
HOW DID YOU SOLVE IT?
USED STRATEGY
JUST KNEW
SKIP COUNTED
Put each fact in the bowl based on how you solved it.
Excerpt from Games and Tools for Teaching Multiplication Facts. ASCD Quick Reference Guide.

14


Next Steps…
Create games to implement into both primary and intermediate classrooms.

15


Session 2
Fluency
Subtraction as an unknown
Exit Ticket Survey
During the last 5 minutes of each session, you will have time to complete an Exit Ticket Survey through Survey Monkey
A link will be sent to your email at the conclusion of each session
Link:
EXIT TICKET

16

Appendix K

Summary Matrix

Research Question	Constructs	Measures or Instrumentation	Data Collection	Data Analysis
RQ 1: To what extent did the intervention adhere to the proposed timeline, number of sessions, content, and activities of the mathematics PLCs and coaching sessions?	Fidelity of implementation-Adherence Adherence is the "methods or implementation that conforms to theoretical guidelines" (Dusenbury et al., 2003, p. 240)	Comparison table (Plan vs. Implementation) Closed ended survey questions	Field Notes Survey Monkey	Descriptive Coding (Lochmiller & Lester, 2017) Descriptive statistics
RQ 2: How did teachers describe the administration's support of the intervention?	Teacher's perceptions of context's needs Context evaluations assess the "needs, problems, and opportunities with a define environment' (Stufflebeam, 2003, p. 31).	Open ended and Likert scale survey questions	Survey Monkey	Descriptive coding (Lochmiller & Lester, 2017) and Descriptive statistics
RQ 3: What was the level and quality of	Participant responsiveness	Attendance and participation record	Field Notes	Descriptive statistics

participant engagement in the mathematics PLCs and coaching sessions?	Participant responsiveness is “ratings of the extent to which participants are engaged by and involved in the activities and content of the program” (Dusenbury et al., 2003, p. 244).	Likert scale, closed and open-ended survey questions Open-ended questions	Survey Monkey Semi-structured focus group interviews	Descriptive statistics and descriptive coding (Lochmiller & Lester, 2017)
RQ 4: How did participating in mathematics PLCs and coaching cycles change teachers’ pedagogical content knowledge?	Pedagogical content knowledge Shulman (1987) defines pedagogical content knowledge as “that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding” (p. 8)	Measuring Content Knowledge for Teaching Mathematics (MKT) Instrument (Hill, Schilling, & Ball, 2004)	Qualtrics	Descriptive statistics
	Teachers’ perception of their	Open-ended questions	Semi-structured	Descriptive coding

	pedagogical content knowledge		focus group interviews	(Lochmiller & Lester, 2017)
RQ 5: How did teachers' level of self-efficacy change after participating in mathematics PLCs and coaching cycles? a. How did teachers' level of mathematics teaching efficacy beliefs change after participating in mathematics PLCs and coaching sessions?	Self-efficacy Bandura (1997) defined teacher self-efficacy as "beliefs in one's capacity to organize and execute the courses of action required to produce given attainments" (p. 3).	Teacher Efficacy Scale (Gibson & Dembo, 1984) MTEBI (Althauser, 2015) Open-ended questions	Survey Monkey Survey Monkey Semi-structured focus group interviews	Descriptive statistics Descriptive statistics Descriptive coding (Lochmiller & Lester, 2017)